COMPRESSED AIR MAGAZINE

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Vol. XVI OCTOBER, 1911 No. 10

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Classified Buyers' Guide, Page 12. Index to Advertisers, Page 8.

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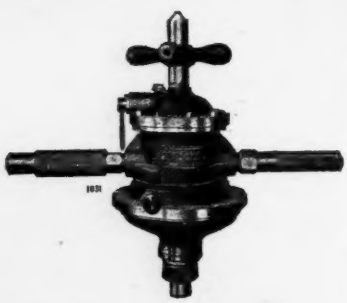

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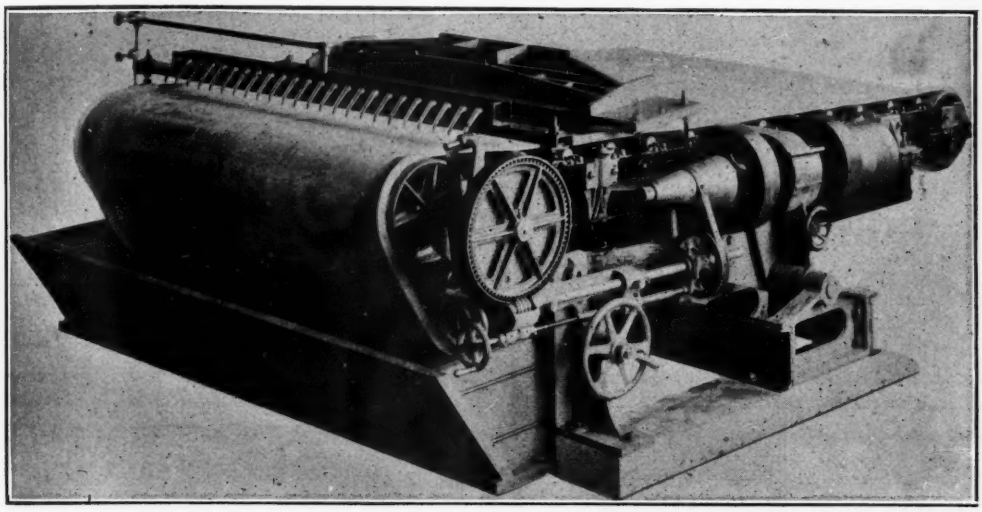

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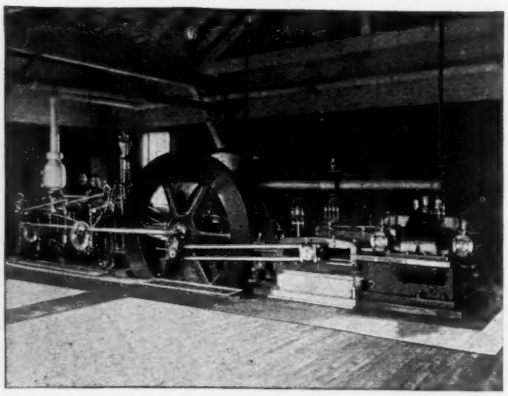

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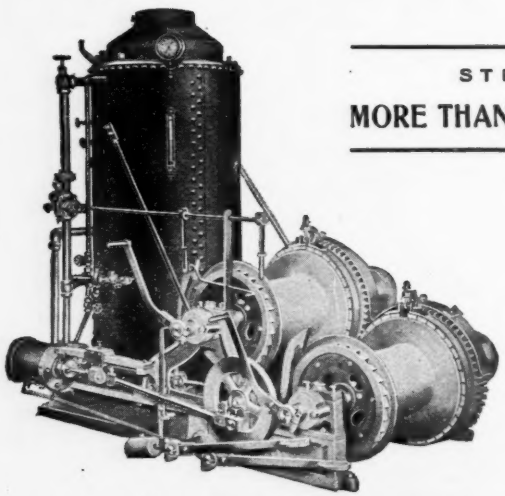

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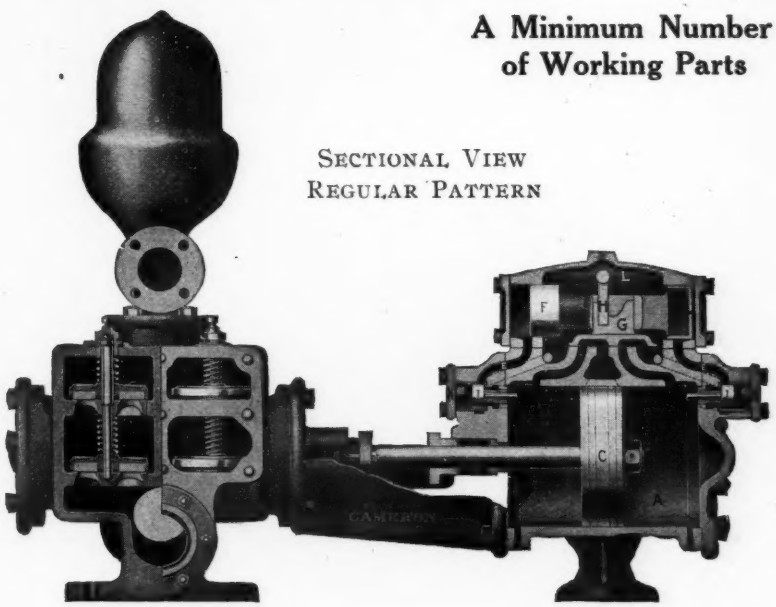

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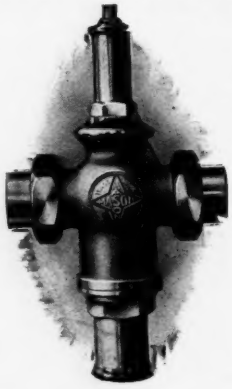

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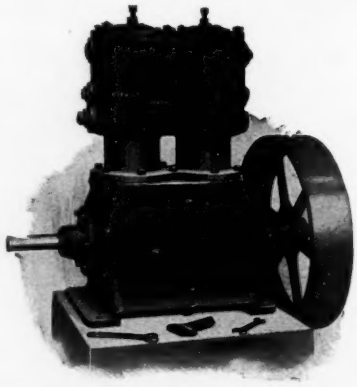

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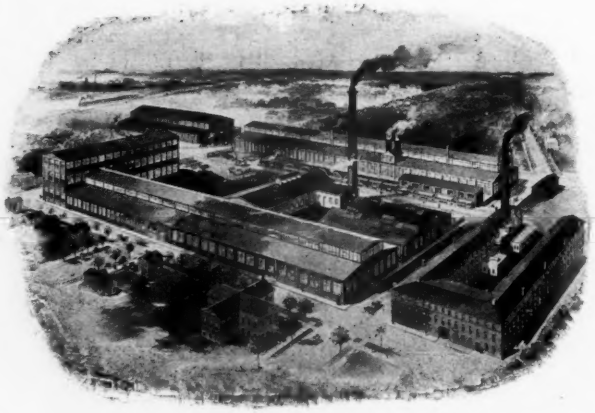

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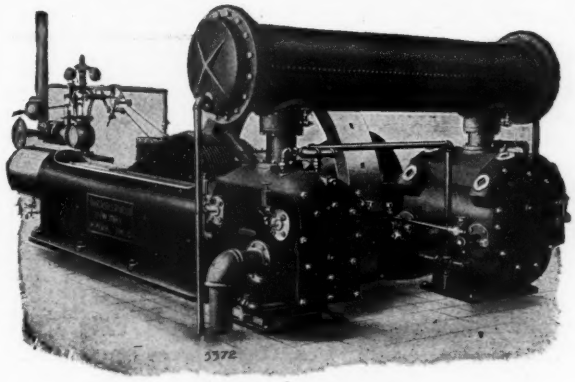

An air compressor may be built of the best materials the market affords, by the best workmen—and still not be a really high-class compressor.

For unless these parts and materials are properly related in a correct, high-duty design, and unless the construction methods are the result of long study—the compressor will be neither durable nor economical.

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INDEX TO ADVERTISERS.

Atlantic Refining Co. 9
Black Diamond 12
Boiler Maker 18
Borne, Scrymser Co 18
Brown & Seward 15
Baldwin Locomotive Works, The 11
Bury Compressor Co. ..... Back Cover
Cameron Steam Pump Works, A S. 5
Chicago Pneumatic Tool Co. ..... Front and Back Cover
Continental Oil Co. 9
Cooper Co., C. & G. 6
Curtis & Co. Mfg Co. 16
Dixon Crucible Co., Jos. 10
Engineering Contracting 15
Engineering Digest .....
Engineering Magazine .....
Engineering News .....
Fiske Bros. Refining Co. 2
Galigher Machinery Co. 3
Gardner Governor Co. 6
Goodrich Co., The B. F. ..... Front Cover
Harris Air Pump Co 12
Ingersoll-Rand Co. ..... 7 and 2
Janney, Steinmetz & Co. 14
Jarecki Mfg. Co. 16
Jewett 14
Lidgerwood Mfg. Co. 4
McKiernan-Terry Drill Co. 18
McNab & Harlin Mfg. Co. 12
Mason Regulator Co 6
Metric Metal Works 19
Mines & Minerals .....
Mining & Scientific Press .....
National Brake & Electric Co. 13
Oldham & Son Co , Geo. 17
Pangborn Company, Thomas W 10
Penberthy Injector Co. 17
Porter Co , H. K. 11
Powell Co., Wm 14
Proske, T. H. 9
Quarry .....
Republic Rubber Co. 10
St. John , G. C. 19
Standard Oil Co. 9
Stearns-Roger Mfg. Co. 8
Sullivan Machinery Co. 4
Vacuum Oil Co. 9
Westinghouse Air Brake Co. ..... Back Cover

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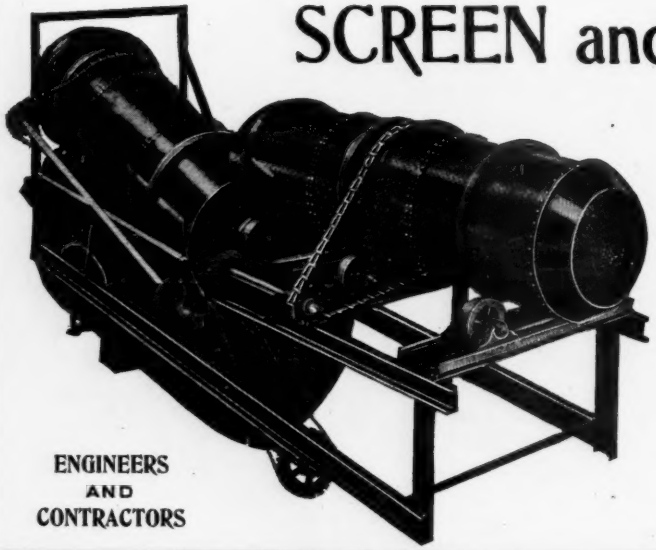

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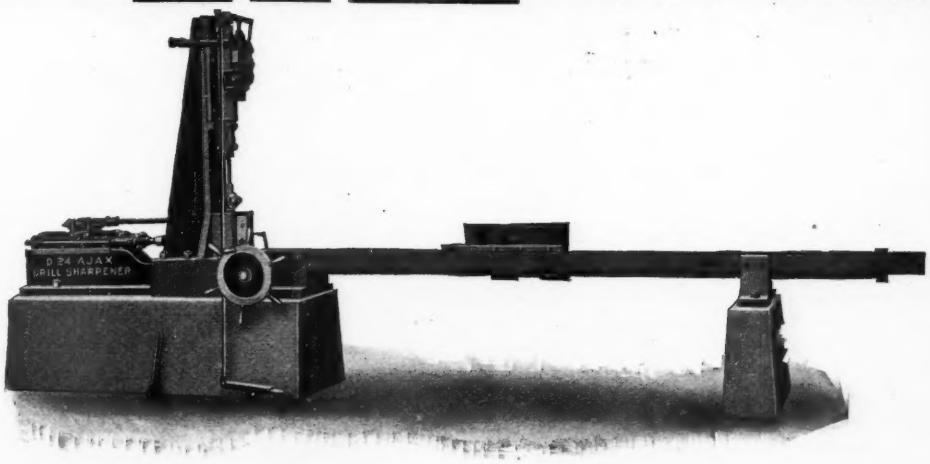

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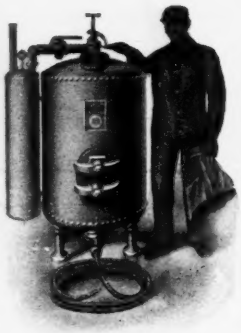

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Then, after 10 days trial, if you are not fully satisfied that you need it, and it will PAY YOU WELL, send it back! The trouble and expense are ours!

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COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XV OCTOBER, 1911 No. 10

TUNNEL DRIVING IN THE ALPS*

By W. L. Saunders.

The first Alpine tunnel was the Mont Cenis, length 7.5 miles, driven with a progress that averaged about 7.75 ft. per day. Next came the Saint Gothard, 9.5 miles long, 18 ft. per day; Arlberg, 6.5 miles long, 27.25 ft. per day; Simplon, 12.25 miles long, 36 ft. per day.

The figures represent progress when driving from two headings, so that by dividing them in two we get the daily single-heading progress. The latest of the Alpine tunnels is the Loetschberg. In this work the world's record has been beaten by a single day's record in one heading of 36 ft. and by an average daily record in one heading of 29.5 feet.

The advance of the heading or "pilot"—irrespective whether it be driven top or bottom—is the factor controlling the rate of advance, as, under normal conditions, the enlargement to full size, timbering, and lining, readily keep pace with the advance of the heading. The manner of mucking in the headings and the time required to do it average about the same. The increased average gain in the rate of advance has been concurrent with the improvement in the machinery employed in the headings. Experience has led to great advances in speed and economy, as will be seen from the particulars of the tunnels through the Alps.

	Length. Miles.	Progress Daily. Linear Yds.	Cost per Linear Yd.
Mont Cenis	7.5	2.57	£226
Saint Gothard...	9.5	6.01	£148
Arlberg	6.5	9.07	£108
Simplon	12.4	12	

In 1857 the first blast was fired in connection with the Mont Cenis work; in 1861 machine-drilling was introduced; and in 1871 the tunnel was opened for traffic.

In 1872 the Saint Gothard tunnel was commenced, and in 1881 the first locomotive ran through it. Mechanical drills were used from the commencement.

The driving of the Arlberg tunnel was commenced in 1880, and the work completed in little more than three years. The main heading was driven along the bottom of the tunnel and shafts were opened up from 25 to 70 yd. apart, from which smaller headings were driven right and left. The tunnel was enlarged to its full section at different points simultaneously in lengths of 8 yd., the excavation of each requiring about 20 days, and the masonry 14 days. Ferroux percussion air-drills and Brandt rotary hydraulic drills were used, and the performance of the latter was especially satisfactory. After each blast a fine spray of water was injected, which assisted the ventilation materially. In the Saint Gothard tunnel the discharge of the air-drills was relied on for ventilation. In the Arlberg tunnel more than 8,000 cu. ft. of air per min. was thrown in by ventilators. In long tunnels the quick transport of materials is of equal importance with rapid drilling and blasting. In the Arlberg, to keep pace with the miners, 900 tons of excavated material had to be removed, and 350 tons of masonry to be introduced, daily, at each end of the tunnels, which necessitated the passage of 450 cars. This traffic was carried on over a length of 3.5 miles on a single track of 27-in. gauge with

*Abstract of a paper read before the American Institute of Mining Engineers, Wilkesbarre, Pa., June, 1911.

two sidings. When the locomotives ran into the tunnel the fires were damped down, and as the pressure in the boiler was 15 atmospheres, the stored-up heat in the water furnished the necessary power.

THE SIMPLON TUNNEL.

Water power was employed for all purposes at each end of this tunnel. It runs upgrade from each end towards its center, hence there is a natural drainage, which saves pumping. The distance between portals is 12.4 miles, and except for a short curve at each end, the lateral alignment is straight.

The work consists of twin single-track tunnels exactly parallel in plan and profile, and lined throughout with masonry. The centers of the tunnels are 55.76 ft. apart; at the summit-level the cross-section is increased in dimensions to accommodate two tracks.

A center bottom drift was first driven by power drills, and then timbered and covered with a closely-boarded roof. From this drift a shaft was driven upward to the roof-line every 164 ft. (50 m.). The top heading was then excavated by working in both directions from each of these shafts. Next in order, the floor of the upper heading is removed and then the two side cheeks of the bottom drift. The lower drift being timbered, no interruption of the traffic in it was caused by the removal of the rock above.

The advance drift was the only part of the operation performed by power-drills. The drills employed were Brandt rotary machines mounted in groups of two on a heavy thrust-bar about 12 in. in diameter. This thrust-bar was pivoted to a drill-carriage and was counter-balanced.

The section at the heading was nominally 6.5 by 9.5 ft., or 61.75 sq. ft., and as the depth of each blast was roughly 4.5 ft., the material removed by each blast ranged from 265 to 275 cubic feet.

The average daily advance was about 16 ft. at the Italian end and from 20 to 21 ft. at the Swiss end. This work was in gneiss rock. In rock of more friable nature, such as anhydrite or calcium sulphate, an advance of as much as 34 ft. in 24 hr. was made. After each blast, the time required to clean the heading, set the drills, complete the boring, and remove the drill-carriage, was more than an hour.

The spoil was cleared from the face by one gang while another gang loaded the collected muck into narrow-gauge cars hauled by horses. No machines were used, all the material being handled by manual labor. The work of clearing the heading was rushed to enable the drills to be put to work as soon as possible. To this end the clearing-gangs were composed of men who had been previously rested by performing light work only, and only the most skilled and energetic laborers were employed. The majority of the workers were from southern Italy. There were 14 or 15 men at each heading, worked in three shifts daily.

The time spent in clearing away the spoil equaled that consumed in drilling, and it is in this clearing that a saving of time is likely to be effected rather than in the process of drilling.

THE LOETSCHBERG TUNNEL.

The main tunnel is 47,678 ft. long, and it was first planned to be on a tangent. On July 24, 1898, when the main heading had reached a point 1.6 miles from the portal, it struck a cleft filled with sand, gravel, and water. There was a sudden and violent inburst of these materials, which in a few moments filled up the tunnel for a length of 5,900 ft., burying 25 workmen and all the drills and other installations beyond hope of recovery. It is estimated that about 8,000 cu. yd. of sand and gravel entered the tunnel. To avoid any further irruption of the materials, the tunnel was walled up by a 33-ft. wall at a point 4,675 ft. from the portal. The new line leaves the original location at a point 0.75 mile from the north portal. No further serious difficulty was experienced in tunneling through the diversion.

Driving of the headings was begun on Oct. 1, 1906, for a single-track tunnel, and continued until Oct. 1, 1907, when it was decided to drive a double-track tunnel; 86 per cent. of the tunnel had been driven by Oct. 31, 1910. The headings met Mar. 31, 1911. On Oct. 31, 1910, the 4,000 ft. of heading which had been abandoned after the cave-in of 1908 had been regained.

The power-plant for the south heading is situated at Goppenstein. It is driven by electric power. The current is brought at 15,000 volts, and stepped down to 500 volts for power-purposes. Compressed air for the drills (Ingersoll-Rand) is furnished by 3 two-stage

FIG. 1. CAR WITH DRILLS SWUNG AROUND TO RUN CAR BACK.

Ingersoll-Rand compressors, each having a capacity of 1,950 cu. ft. of free air per min., and a compression of 145 lb. per sq. in. They are driven by 400-h-p. electric motors. Compressed air for the locomotives is furnished by 2 four-stage Ingersoll-Rand compressors, having a capacity of 460 cu, ft. of free air per min., and a compression of 1,760 lb. per sq. in. They are driven by 250-h-p. electric motors.

At the north heading air for the drills is furnished by two units, each consisting of a two-stage Meyer air compressor, each having a capacity of 1,770 cu. ft. of free air per min., and a pressure of 117 lb. per sq. in. They are belt-driven by 450-h.p. electric motors.

Compressed air for the locomotives is furnished by two units, each consisting of a five-stage Meyer high-pressure compressor, with a capacity of 565 cu. ft. of free air per min., and a pressure of 1,760 lb. per sq. in. They are belt-driven by a 250-h.-p. electric motor.

The records made in driving the headings are due to the excellent organization, and to the methods of setting up and taking down the drills. A drill-carriage of simple but efficient design was devised by the contractors. Each carriage carries four or five drills. Fig. 1 is a view of a carriage with drills mounted and swung into position to be taken from the heading before a blast and Fig. 2 shows the carriage with bar and saddles for four drills swung crossways as in use. Fig. 3 shows the carriage, together with the drilling-machines, when brought forward just after mucking in the heading. Fig. 4 shows the horizontal shaft swung into position ready for being jacked, and the drills ready to be swung into the position shown in Fig. 5. It can be easily seen from Fig. 5 that the drills can be independently swung through an arc of a circle or moved sideways, while in Fig. 6 the different positions which the drills can be given by being swung in a vertical plane are shown.

The time required to change the machine from the position shown in Fig. 3 to that shown in Fig. 5 and to commence drilling is usually from 6 to 8 min. This fact alone shows the superiority of this system of carrying the drills for such work over any other method used up to the present time.

The sequence of excavation is illustrated in Fig. 8. A bottom heading 6.5 by 10 ft. is first driven several hundred feet in advance of the

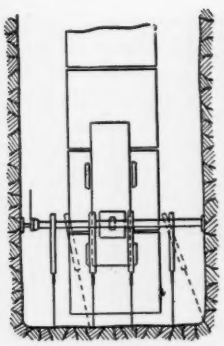


FIG. 5.—HORIZONTAL ADJUSTMENT OF DRILLS.

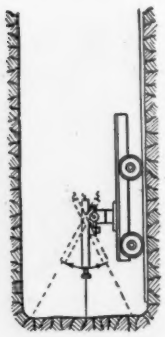
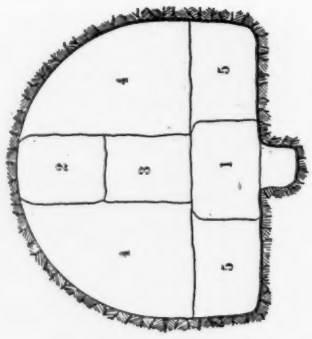


FIG. 6.—VERTICAL RANGE OF DRILLS.



Excavation-Diagram

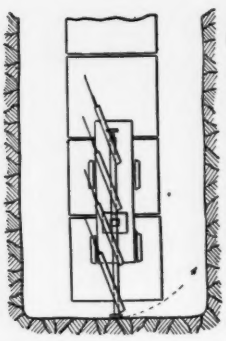


FIG. 3.—CARRIAGE BROUGHT FORWARD AFTER MUCKING.

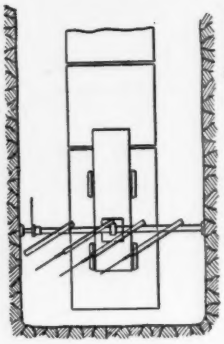
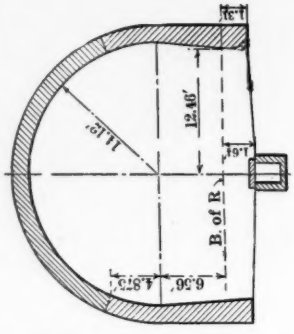


FIG. 4.—DRILL-SHAFT IN POSITION TO BE JACKED.



Standard Section.

FIG. 7.—STANDARD SECTION AND EXCAVATION-DIAGRAM OF LOETSCHBERG TUNNEL.

enlargement. Upraises are then driven from 500 to 600 ft. apart, and a top heading started back and forth. The top heading is then enlarged as shown by the sections in Fig. 8.

When the inclination of the strata is vertical or the formation is of a treacherous nature, the method illustrated by Sections B-B and E-E in Fig. 8 is used.

In the bottom heading the mining-operations proceed as follows: The drill-carriage is run forward from its siding close to the face of the heading, passing over 5 ft. by 5 ft. by ⅜-in. steel plates laid on the floor of the heading for a length of about 30 ft. Each plate is provided with 1-in. holes at the corners for ease in handling with a pick.

The water-and air-pipes laid on one side of the heading to about 40 ft. from its face are connected with the drill-carriage, and the drilling begins with the top holes. Water-sprinkling is frequently done, especially in starting the holes, in order to lay the dust.

Without interfering with drilling, mucking is going on just behind the drill-carriage, and the loaded muck-cars are run back to a siding, where trains of from 20 to 30 cars are formed and hauled out by air-locomotives.

Drilling being completed in the heading, the drill-carriage is run back to its siding, and the steel plates laid on the floor are covered with a layer of muck about 4 in. thick to prevent deterioration.

The bore-holes are then loaded and carefully tamped, and the last man to leave the heading, after firing the fuse, opens the air-pipe valve, and escaping air thus creating a cushion of fresh air from the face of the heading back to a certain distance, so that, after, blasting, the muckers are able to go to work without delay.

A high-grade explosive only is used in the heading, which breaks the rock in small pieces and renders mucking with shovels easy. The bore-holes, having an average depth of about 4 feet, are started with a 3-in. drill and finished with a 2-in. drill. On account of giving better results, firing is done with fuses, about 4 ft. long, the center holes being fired first.

Mucking-operations proceed as follows: Two empty cars are run to the heading, the first one being immediately loaded by two or three men shoveling without interruption until the car is fully loaded. This operation is

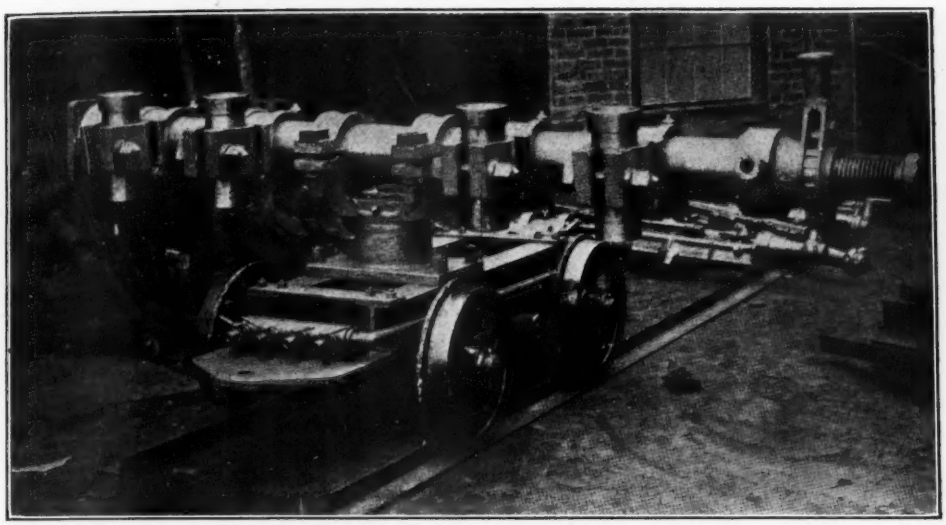


FIG. 2 BAR IN POSITION FOR WORKING FOUR DRILLS.

performed in 3 or 4 min., which means that 1 cu. yd. is loaded in from 2.5 to 3 min.

Owing to the manner of drilling and blasting and to the shallow holes, the muck, instead of piling up in front of the face of the heading, is thrown back, and forms a layer over the floor, which enables the track to be cleared rapidly.

Getting rid of the muck is always a problem in tunnel-driving. At Loetschberg a cubic-meter car (35.5 cu. ft.) is filled in 5 min., and it takes only 1 min. to get this car away and bring an empty car to the heading. In order to do this, small entries or chambers are excavated at intervals in the lateral wall of the main heading, which enable an empty car to be thrown from the track on the side, thus clearing the track and allowing the filled car

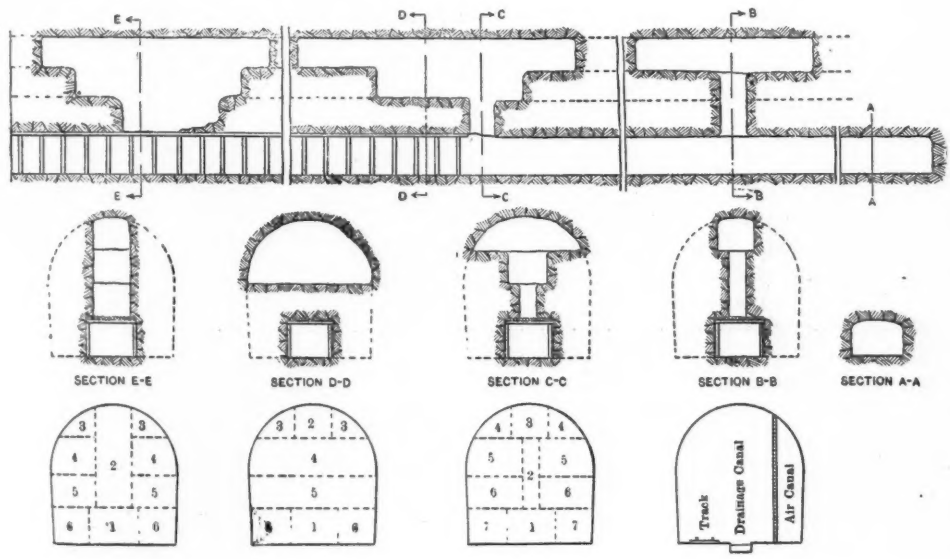


FIG 8

to pass, whereupon the empty car is turned up on its wheels and rolled into the heading. Here we have an illustration of an improvised siding in a narrow heading, by means of which one car may pass another. This system is shown in Fig. 9, the operation being as follows:

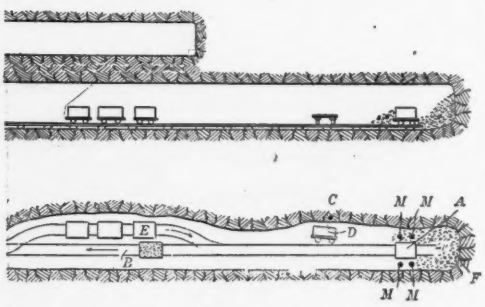


FIG 9.

When the car, *A*, is filled, it is taken away on the track, *B*, and immediately after it has passed the point, *C*, the empty car, *D*, which had been reversed on its lateral side, is thrown back on the track, brought to the advancement and filled again in the space of one minute. As soon as car, *D*, has been brought to the advancement, another empty car, *E*, is brought to the same point, *C*, reversed on its side, and waits until car, *D*, is filled and taken away again, etc. In one instance, 14 carloads, each of 1 cu. m. volume, were taken away in 1.5 hr., which cleared the heading completely and allowed the drill-wagon to be brought in. Ten men are busy removing the debris, two of which number get at the extreme limit marked *F*, and their work consists in searching the debris for the dynamite cartridges which might not have exploded. Of the remaining eight men, four work to fill the car, as shown at *M*, which takes 5 min.; they then rest for 5 min., while the second gang of four men come and fill the second car, etc.

Drilling is started not more than 5 min. after the removal of the last car-load. This result, which at first sight seems impossible, is only obtained by absolute discipline.

The man who knows that his only work at this moment is to connect the air-main to the drill-carriage does not do anything else; the men whose duty it is to screw the carriage tightly to the wall immediately jump to the right place.

The system has been adopted of low and wide gallery in the proportion of 1:2; the gallery being 6 ft. high by 12 ft. wide.

The rate of drilling is, 15 or 16 holes in 1.1-1.15 hours.

Drilling in the top heading is accomplished by means of two or three drills carried on tripods or on a horizontal bar, while hammer hand-drills are used generally for the enlargement.

Mucking-operations in the top heading are very simple, since all blasted material is dumped directly through the up-raiser into cars running on a siding in the bottom heading.

The operations of blasting, mucking, timbering, and hauling are performed without interruption and without interference with each other, and a special force of engineers is required in order to obtain such a result.

All employees and workmen are insured against accident or death, by the contracting company, and great care is therefore exercised in handling explosives and in operating the trains.

UNRELIABLE CURRENTS OF THE UPPER AIR

An English investigator, in a recent lecture before the Aeronautical Society, stated the following facts which he had observed: On an island, the wind has a greater velocity a few hundred feet above the ground. Above 2,000 ft., an easterly wind does not increase much. A southwesterly or westerly wind increases even between 2,000 and 3,000 ft. A wind that is southeasterly in the stratum near the earth veers to south or even southwest at a short distance from the ground. A northerly wind sometimes changes direction higher up, becoming northwesterly. As a general rule, for other winds than northerly, a change in direction of two points on the compass (one point equals an angle of 11¼ degrees, the compass having 32 points) and a doubling of the velocity may be expected between the ground and an altitude of 3,000 ft., excepting on warm, sunny spring and summer days, when the currents mix and become equalized.

The English journal, *Flight*, adds the following facts: The limits between which a 20-mile wind varies are 15 miles and 25 miles. The time interval between variations may be less than four seconds, as many as 17 changes

in one minute having been observed. These variations affect not only the velocity but also the direction. One has not been able, however, to find any regular coincidence of the changes in direction and velocity.

Flug-Zeitschrift, published at Vienna, gives an account of similar investigations, the results of which, in the main, correspond with those obtained in England. In this journal an attempt is made to explain the phenomena as being caused by the earth's rotation and by obstructions on its surface.

A writer, in *L'Aero,* recounts similar experiences reported by French airmen who also call attention to sudden gusts of wind in a vertical direction, whereby the aviator may be suddenly elevated 70 to 80 ft., and as suddenly brought down again, or vice versa. The changes in the horizontal plane are not much feared by experienced airmen, but they often precede and give warning of a gust in the vertical direction, and the aviator should be on his guard.

FIG. 1. PNEUMATIC HAMMERS AT ZURICH.

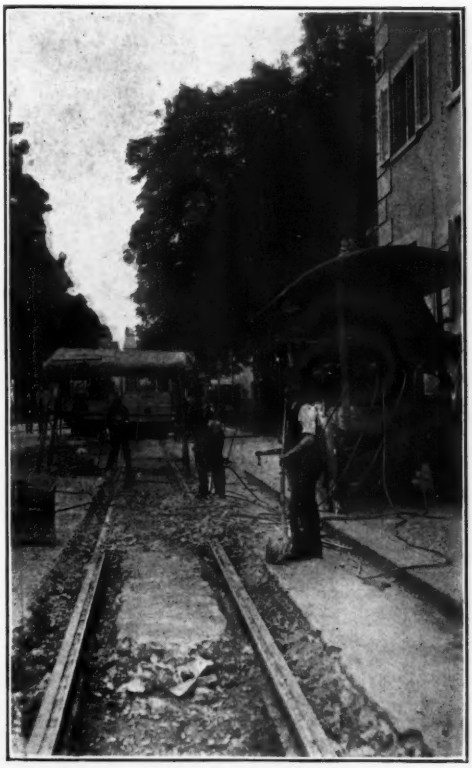


FIG. 2. AFTER THE HAMMERS.

PNEUMATIC HAMMERS FOR TEARING UP STREET PAVEMENTS

By Frank Richards.

A job of all too frequent occurence is the tearing up of street pavements for the laying or changing of rails, pipes, wires, etc. It is always hard work, and in the way in which it has generally been done by hand it has been also costly and in many respects unsatisfactory. Figs. 1 and 2, which are almost entirely self-explanatory, show how this work has recently been done on an extensive scale in the streets of Zurich, Switzerland, by the use of Ingersoll-Rand pneumatic hammers.

The city Tram Co. of Zurich had miles of track to relay, and as the rails were bedded in concrete it was necessary to tear this up for a certain distance outside the rails and all of it between the rails. The track gage as given the writer is 3 ft. 3 ins., but is probably one meter. The data for the account which follows I have received from Mr. J. Waldenberg of Düsseldorf, Germany.

The portable air compressor outfit used, seen at right in Fig. 2, was mounted on a special flat truck having four wheels of wide face, with long plate springs to the axles. The 8x8-in. single-stage Ingersoll-Rand compressor was belt driven by a 550 volt, D. C., 21 H. P. motor, the belt having a tightener actuated by a lever and weight. A vertical air receiver and a water tank of about 18 cu. ft. capacity were provided and a tool box was attached below the truck frame. The tools used in connection with this air supply were four heavy chipping hammers, equipped with round bushings.

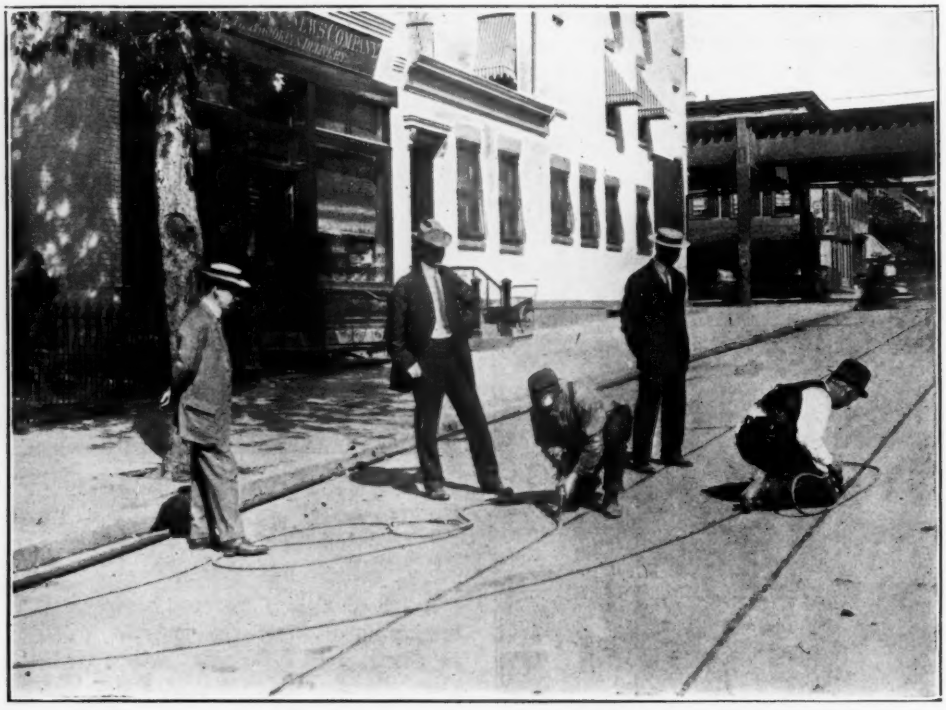


FIG. 3. CUTTING ASPHALT, BROOKLYN.

On each side of each rail, the workmen tear away by means of these hammers strips about 6 to 8 ins. wide, thereby freeing the rails from the concrete, which is about 10 ins. thick. After these strips are cut away, solid pieces of concrete 10 to 20 ins. long are lifted by crowbars from between the rails, also from between the rails and the sidewalk. It is then an easy matter to break up these large blocks with sledges.

The chisels or picks used in connection with the hammers were made of ordinary machine steel, as the company found out by experience that it does not pay to use a good grade of tool steel for this kind of work. When made of hardened steel, the chisels break much easier than if soft steel is used, the breaks occurring in the shanks as well as at the points. The shanks are round and the points are chisel shaped, the chisel being tapered down with a long slant at the sides so that the straight cutting edge is only about ¼-in. wide. This shape proved to be the most satisfactory, as if made with a point the bits broke in a very short time regardless of the material of which they were made.

Four men, each operating a pneumatic hammer, would accomplish about as much work as 16 to 20 men working entirely by hand. One pneumatic hammer therefore takes the place of from four to five common hand-hammers and chisels. One man can cut with one hammer per hour a strip 8 to 10 ft. long, and as the strip is about 8 ins. wide the average work for one pneumatic hammer per hour is about 5.3 sq. ft. This capacity refers to

FIG 4. THE ASPHALT FURROW.

work in solid, hard concrete. It is to be taken into consideration, the writer is informed, that the workmen in Zurich do not exert themselves too much, being employed by the city and being entitled to minimum wage regardless of the amount of work done. On the other hand, of course, the interest and depreciation on the plant, the cost of transportation, power consumption, etc., would have to be considered in making a fair estimate of the advantage gained by the use of the pneumatic outfit.

CUTTING ASPHALT AND MACADAM.

It is to be remembered that the work at Zurich above described was the cutting of concrete. In entire ignorance of this operation there has been developed almost simultaneously by the Brooklyn Union Gas Co. at Brooklyn, N. Y., a quite similar application of the pneumatic hammer, but in this case for cutting asphalt pavement. Those who have seen the operation of breaking up or breaking into an asphalt street pavement by the old methods will realize not only the strenuousness of the task but also the difficulty of following any precise line of cleavage. The method of cutting the asphalt with the pneumatic hammers is graphically told in Figs. 3, 4 and 5. A chalk line is marked on the surface and the chisel follows the line exactly, turning the asphalt over as if it were leather, although in hardness and tenacity it is more like copper or iron. In this case, the hammers were used for breaking up the surface where a 4-ft. gas pipe was to be laid through the street. Mr. E. J. Byrne is chief engineer of District No. 1, in which the work lay, and Mr. E. D. Jones and Mr. John E. Setchell were the assistant engineers in immediate charge of the work.

The portable air-compressing outfit was mounted on a truck similar to that in use at Zurich, but with an Abenaque gasoline engine for the driving instead of the electric motor, and an Ingersoll-Rand compressor as before. A 2-in. iron pipe was laid on the surface of

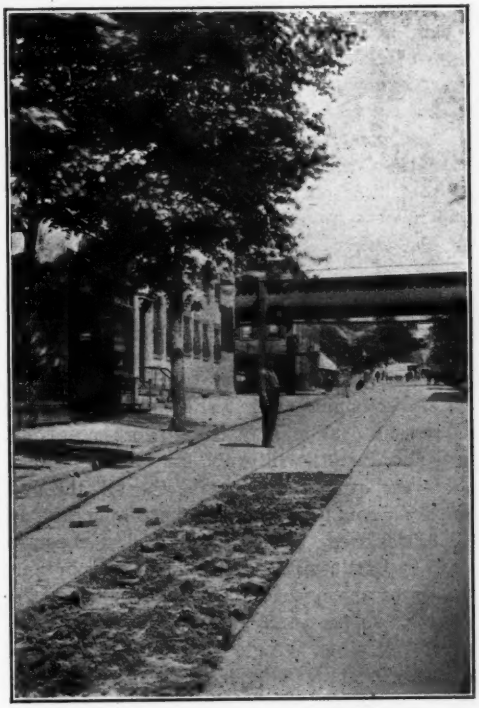


FIG. 5. READY TO DIG TRENCH.

the pavement close to the curb and was connected to the receiver of the compressor. The tools could then be connected at various points along the pipe, obviating the necessity of frequently moving the compressor as the work progressed. There was here as well as in Zurich some experimenting as to the best hammer to use, the one finally adopted being of a type extensively used in coal mines. The cutting tool was like a big chipping chisel, an inch and a half wide. This was run along the two lines defining the width of the trench, cutting through the asphalt and giving it a turn partly over as a plow would do. The sheet of asphalt was then pried up by a crowbar gang, while one man would break it with a sledge.

Some data of the actual rate of cutting the asphalt with the pneumatic hammers are furnished the writer by Mr. John E. Setchell as follows:

From observation of about 3,000 linear feet of cut (1,500 ft. of trench), with two men and sometimes three using the hammers, the average asphalt cut was 20 ft. per man per hour.

On June 1, 1911, on a 45-minute hand test (hand-held chisel and sledge) we cut at the rate of 12 ft. per man per hour, but the men were exhausted and had to stop.

The material under the asphalt was macadam, close and hard, and for breaking this also the "coal picks" did good service. The chisels were exchanged for pointed picks for this work.—*Engineering News,* with additions by the writer.

SQUANDERING THE PRINCIPAL

You may take all the water from a well and the rainfall will restore the water. You may exhaust the fertility of the soil, but by careful cropping and fertilizing the fertility is renewed. You may cut down the forests, and new forests will grow, but when you take from the earth the minerals, the oil, the gas, the coal, contained therein, these minerals are never replaced. When gas was first encountered in Bartlesville, Oklahoma, it was permitted to escape unchecked. The roaring of the gas was so persistent that people in the town could not sleep at night, and so the gas was carried in pipes outside of the city limits, where it might escape without the noise disturbing the sleepers.

EMERGENCY PNEUMATIC PUMPING

A threatened shortage in the water supply for St. Paul, Minn., during 1910 made it necessary to provide means for supplementing the flow from the existing water-works system. The original supply is obtained from a system of lakes, north of the city, having a drainage area of about 100 square miles, including the lake surface. From this area, in addition to the water used for the city's supply, there is usually a large runoff which might be held by increasing the reservoir area. The year 1910 was the driest ever recorded by the water department, whose statistics cover a period of 74 years; the total precipitation was a little more than 10 in., while the average rainfall is 28 in. It became apparent in June of last year that the lake supply was in danger of being exhausted and if another dry year should follow there would certainly be a great deficiency in the water supply. Some immediate action had to be taken and as there was no other lake or river which could be utilized within the time required Mr. L. W. Rundlett, then Commissioner of Public Works, recommended the sinking of artesian wells at the existing McCarron Lake pumping station, located at the end of a conduit 4½ miles long which carries the water from Vadnais Lake, the nearest of the lakes in the present supply, to a terminal chamber, from which point it flows by gravity into the low service system and is pumped into a reservoir for the high service system.

In accordance with this recommendation, six 12-in. artesian wells were sunk to a general depth of 700 ft. (one well being carried down to a depth of 1000 ft. without materially increasing the flow). It was hoped to obtain flowing wells, but the height with which water rises from the sandrock strata varies considerably in different localities in the vicinity of St. Paul. In this instance the water rose to an average height of about 18 ft. below the surface of the ground. Tests of two wells showed a suitable supply of water both in quantity and quality. Under the existing conditions it seemed expedient to place a separate pumping unit at each well and to deliver the water through a pipe system to the terminal chamber, where it could be used on both the high and low services.

Bids were received for installing either an air plant or an electric plant. The lowest

price with the highest guaranteed efficiency was secured on the air plant, and the contract was awarded to the Robinson, Cary & Sands Company, in the sum of $27,817.00, they furnishing the air compressor, condenser, air pump and everything necessary to operate the machine, all the air piping, including the well connections, the towers and tanks into which the water was discharged, (the water being carried by gravity from the tanks to the terminal chamber), while the Board of Water Commissioners furnished the addition to the pumping station for the compressor, the additional boiler capacity required and the piping from the boiler to the compressor, steam at 125 lb. pressure, the necessary water pipe system to take the water from the wells to the terminal chamber and a weir for the accurate measurement of the water as furnished.

The efficiency based upon the computed foot-pounds of work in the steam supplied was guaranteed to be not less than 4.83 per cent. with a penalty of $100 for every one-tenth of 1 per cent. below this standard and a bonus of $100 for every one-tenth above.

The result of the test was as follows:

RESULTS OF TESTS OF COMPRESSED AIR PUMPING PLANT.

Duration of test from 8 a. m. to 5 p. m.	9 hours.
Average r.p.m. of compressor	80.26
Average steam pressure gauge, lb. per sq. in.	126.4
Average vacuum referred to 30-in. barometer	26.9 in.
Total pounds of condensed water	35,651
Average temperature of condensate	101.5° F.
B.t.u. per pound of steam at average pressure	1189.7
B.t.u. per pound of condensate	69.1
B.t.u. consumed	1120.6
Av. cu. ft. water per second over weir = 6,350,000 gal. per day.	9.78
Average total head in feet	76.83
Total foot-pounds water delivered ÷ total foot-pounds steam consumed = efficiency =	4.90%
Efficiency covered by contract	4.83%

This result gave the contractor a bonus of $70.

The plant in the test delivered at the rate of 6,350,000 gal. per day against an average total head of 76.83 ft. The cost of running the plant in connection with the pumping engine already installed is about $35 per day.

The air compressor is an Ingersoll-Rand machine with compound steam cylinders and cross-compound air cylinders rated at 2,588 cu. ft. of free air per minute at 125 r.p.m., the air to be delivered at 100 lb. per square inch gauge pressure. The condenser is a Wheeler surface condenser containing 525 sq. ft. of cooling area made up of ¾-in. brass tubes. The boiler feed is warmed by a Wainwright feed-water heater having a rating of 300 h. p. equipped with a Harris Air Pump Company's pump constructed of bronze, and standard well tops and umbrella discharge equipment. Over each well there was placed a substantial steel tower, supporting a steel tank 5 ft. in diameter by 6 ft. high.—*Engineering Record.*

UNWATERING A CUBAN MINE WITH THE AIR LIFT

By E. H. Emerson.*

In 1910 an interesting experiment with the air lift was made at El Cobre Mines. The following are the results:

The water stood at the 200-foot level, held by two Cameron station pumps. The shaft was 800 feet deep, with one cage road, 4x8 feet, open to the 800-foot level. The other compartments were blocked with platforms. Water was acid, and contained up to 400 grs. Cu per cubic meter. A tunnel from the 50-foot level through the mountain allowed a reduction in the head.

INSTALLATION FOR BLOWING.

Tests showed the shaft to be blocked by old timber and guides, so that a cone was made to run on an old cable guide, lowered in the center of the compartment with a two-ton weight. The wood pipe was built upon this and lowered as put together.

The wood pipe twisted around the center cable in a spiral, so that it had made a complete turn in 200 feet without doing the slightest harm. Three columns were built up on the cone and tied together with new 1½-inch rope, which, when wet, held them together very firmly. They were 750 feet long, each, and had no support, as the guide and lowering ropes were soon eaten off by the water.

With 600 feet under water and 150 feet above, the wood columns were nearly floating. After being water-soaked they become very heavy.

The wood pipe was 10 inches inside diameter. Air pipe was 2½-inch iron pipe, which was thoroughly tarred and changed as it was eaten by the water.

The high limit of our compressors was 140 pounds pressure.

Two pipes were used, the third being in re-

*Manager, El Cobre Mines, Cuba.

serve and operated in case of breaks in the others.

RESULTS OBTAINED.

The out-flow was measured hourly by weir.

The head at the start was 150 feet, submergence of air pipe 50 per cent. Head of finish was 360 feet, with 39 per cent. submergence.

The water removed was 113,120,000 gallons. Cost 7.434 cents per 1,000 gallons.

The pipes averaged 950 gallons per minute, each, or 105 cubic feet of air for 100 gallons of water.

The lowest speed was with 360 feet head, 1,500 gallons per minute for the two pipes, or 160 cubic feet of free air for 100 gallons of water.

SECOND STAGE.

After reaching the 400-foot level, a 2,000-gallon pump was installed, and the discharge of the blow pipes turned into the pump sump.

Under no head, one-inch pipe threw 2,200 gallons per minute with air cut down. This was the pump limit on a burst of speed.

A special test was made in lowering the water for seven days. The results were as follows:

SEVEN DAYS TEST BLOWING AND PUMPING.

Feet lowered	57′ 6″
Feet lowered per day.....	9′ 2½″
Gallons per foot lowered.....	307,100
Gallons pumped, total.....	17,659,980
Gallons pumped, per day.....	2,522,954
Gallons pumped, per minute..	1,750
Head on blow-pipe, at start..	21′ 6″
Head on blow-pipe, at finish..	79′
Head on blow-pipe, average..	50′ 3″
Submergence at start.....	179.89 per cent.
Submergence at finish.....	100.50 per cent.

Air pressure, 100 lbs., gage.
2½ inch air pipe inside 10 inch wooden pipe.
43 cubic ft. of free air to 100 gallons of water.
Cost: 2.32 cents per 1,000 gallons.

In this case the pipe was limited by the capacity of the pump; 3,500 to 4,000 cubic feet could be blown from the one pipe with 1,000 cubic feet of free air. The actual inflow of the mine is 213 gallons per minute.

The cost per 1,000 gallons by blowing down 60 feet once in two months, and pumping the water to the surface is 5.23 cents per 1,000 gallons. The cost for the pump alone, working at its full capacity, is 2.91 cents per 1,000 gallons (with labor proportioned to the blowing), but handling only the inflow with pumps of smaller size the cost was 8.3 cents per 1,000 gallons. There is therefore a savnig of 3.02 cents per 1,000 gallons by the combination method of holding the water at the 400 foot level. This is a real saving, since in flood time the full 2,000 gallon capacity is necessary, and therefore there is no unnecessary investment. A great advantage is that an enormous sump is provided, which insures against drowning by the sudden floods.—*Mexican Mining Journal.*

POWERFUL EFFECTS FROM MINUTE VIBRATIONS

The following, from the *Scientific American,* having to do with the effects of rapid vibrations upon metals and other solids, and then the exciting of such vibrations by means of sound waves transmitted through the air from musical instruments, of course is entirely pertinent to our columns, as are all phenomena in which air—which always is compressed air—is concerned.

It has been contended that solid metals may reveal by their structure the vibrations to which they have been subjected. In explaining this phenomenon, experiments were made in England to show that a beautiful wave structure can be imparted to the surface of mercury by the vibrations of a tuning-fork, and that even the surface of solid lead which has been subjected to similar vibrations possesses a structure resembling that of a vibrating surface of mercury. Mild steel was defined as a "solid solution" of iron and carbon, free from cinders. Metallurgists have doubled the strength of steel as it was known in early days.

Iodide of nitrogen, a black powder, is one of the most dangerous of all explosives. When dry, the slightest touch will often cause it to explode with great violence.

There appears to be a certain rate of vibration which this compound cannot resist. In experiments to determine the cause of its extreme explosiveness, some damp iodide of nitrogen was rubbed on the strings of a bass viol. It is known that the strings of such an instrument will vibrate when those of a similar instrument, having an equal tension, are played upon.

In the present case, after the explosive had become thoroughly dry upon the strings, another bass viol was brought near and its strings were sounded. At a certain note the iodide of nitrogen on the prepared instrument exploded.

It was found that the explosion occurred only when a rate of vibration of 60 per second was communicated to the prepared strings. Vibration of the G string caused an explosion, while that of the E string had no effect.

The question is often asked, What force least expected does the greatest damage to buildings? One architect's answer to this question may be a surprise to those who do not understand that it is the regularity of vibration that makes it powerful.

"I venture to say," remarked this architect, "that you would never suspect that violin-playing would injure the walls of a building. Yet it certainly does. There have been instances when the walls of stone and brick structures have been seriously damaged by the vibrations of a violin. These cases are, of course, unusual, but the facts are established.

"The vibrations of a violin are really serious in their unseen, unbounded force, and when they come with regularity, they exercise an influence upon structures of brick, iron or stone. It follows, of course, that there must have been continuous playing for years to cause the loosening of masonry or to make iron brittle, but it will do so in time."

OXYGEN CONSUMED BY A LAMP

The most recent tests to show the oxygen-consuming power of a naked flame are some experiments in Scotland: A lamp burning oil consumed 1.13 cu. ft. of oxygen, and produced 0.78 cu. ft. of carbonic acid per hour. The same lamp when burning tallow, consumed 2.49 cu. ft. of oxygen, and gave off 1.74 cu. ft. of carbonic acid in one hour. The investigators determined the candlepower of various lamps by photometry. An oil lamp (naked flame), consuming 13.8 grams of oil per hour, averaged 1 c.-p. The kind of oil used, of course, affects th ecandlepower considerably. A miner's tallow lamp consuming 17.4 grams of tallow per hour, averaged, with uniform flame for 15 min., 2.3 c.-p. A lamp consuming 13 grams paraffin wax per hour gave 1.6 candlepower.

DEVELOPMENT IN COMPRESSED AIR POWER STORAGE

By Frank Richards.

One of the most unsatisfactory features of compressed-air practice up to the present time has been in the inadequacy of the means provided for storing the air between its compression and its use, or for maintaining a full and constant pressure under a varying rate of consumption. It may be said that compressed air wherever employed, is always used more or less intermittently, and never at any constant rate, except in cases where the entire output of a compressor or of a large compressing plant is employed in a single water-pumping operation.

The air receiver usually provided with an air compressor has a total air capacity not exceeding the output of the compressor for a single minute, so that, if the compressor stops or is slowed down to below the capacity to supply the consumption, the pressure instantly begins to fall. To insure somewhat reliable maintenance of pressure and volume it is the practice to provide a maximum compressing capacity somewhat in excess of the maximum demand, and then to automatically reduce the speed of the compressor as the rate of consumption diminishes. Even this arrangement usually does not completely satisfy the fluctuating requirements, and so we have various unloading or choking contrivances which will still more reduce the output without actually stopping the machine. However satisfactory the results thus obtained may be, it is evident that they are secured only by more or less complication of apparatus and a sacrifice of the essential conditions of power economy in the running of the machine.

A magnificent opportunity for the solution of this air-power storage problem opened to the engineers of the Anaconda Copper Mining Company, at Butte, Mont., when it was proposed to find a cheaper means of driving their great mine hoists than by the use of steam. There were at Butte 25 large steam-driven hoists with an aggregate capacity of 40,000 horsepower, but the service required of the hoists was so intermittent, and the actual time of working of each was so short, that it was estimated that 4000 horsepower in constant operation would be sufficient for all the requirements, but it was imperative that the power should be always ready and always sufficient for each individual hoist.

The cost of steam had been about $80 per horsepower yer pear, while electric horsepower per year could be had for about $25. There were, however, serious objections to the adoption of the electric drive for each separate hoist, besides the enormous first cost of such an installation. Here, also, there could be no power storage, so that it would be necessary at times to have current available for nearly all the hoists at once.

So far as the steam hoisting engines were concerned, they could be adapted to the using of compressed air at comparatively slight cost, if only the power-storage problem could be solved, so that a constant drive of sufficient average capacity could be made able to take care of the peak loads whenever they should occur, even up to the running of all the hoists at once. The problem has been solved with a success and completeness seldom surpassed in great engineering undertakings.

It is not intended here to give more than the briefest sketch of the compressor installation and operation, the purpose being only to call attention to the air-storage scheme.

The electric current which drives the compressors is transmitted 130 miles from the new plant at the Great Falls Water Power and Townsite Company, at Rainbow falls, just below the Great falls on the Missouri river. There are three compressors, each with a direct-connected Westinghouse motor of 1,500 maximum horsepower. The compressors, furnished by the Nordberg Manufacturing Company, are two-stage machines of the highest class, with low-pressure cylinders 50 inches diameter and high-pressure cylinders 30 inches diameter, and a common stroke of 48 inches. The combined free-air capacity of the three compressors I would estimate roughly at 20,000 cubic feet per minute (not knowing the builder's specifications as to speed, etc.)

THE AIR RECEIVERS.

From the compressors the air passes to the battery of air receivers. There are 32 of these, vertical, each 10 feet diameter and 30 feet high, their combined cubical content being, say, 70,000 cubic feet, which, at 90 pounds gage pressure, may be said to equal 500,000 cubic feet of free air, a volume which it would take the combined compressors nearly half an hour to compress and deliver. This is very different, to begin with, from the less than one minute capacity of the air receiver usually provided.

But there is a more important feature and a greater difference and advantage to be noted in the present installation as compared with long established air receiver practice. The too familiar experience is that as soon as any air is withdrawn from the receiver in excess of what the compressor is delivering, or if for any reason the compressor stops, the pressure in the receiver falls rapidly and constantly with the drawing of the air. Under the arrangement here being considered, when the quantity of air contained in the receivers is diminished by any air consumption exceeding the delivery, instead of a drop of pressure rendering the remaining contents of the receiver ineffective and useless, the pressure is maintained and the entire contents of the whole battery of receivers, including the original inert filling of air at atmospheric pressure, can be used at full pressure and effectiveness until the receivers are emptied. In practice the withdrawal of the air never goes as far as this. As these compressors run all day and all night, when there is at any time a simultaneous call for operating an unusual number of hoists, there is always the full capacity of the working compressors and also the entire contents of the battery of receivers to draw from until the unusual and excessive demand for air ceases. When there is such an unusual simultaneity of hoisting it is necessarily succeeded by a period when the hoisting and the demand for air are less than the compressor output, and then the receivers are automatically filled again.

HOW THE AIR PRESSURE IS MAINTAINED.

The device by which the air pressure is maintained in the receivers nothwithstanding the diminution of the contained air is essentially a simple one. It is accomplished by the use of a standpipe or its equivalent, the same as in waterworks service. On a side hill at an elevation sufficient to give the required gage pressure of 90 pounds, there is an open water tank 100 feet in diameter and 15 feet deep. A depth of 10 feet in this tank gives a water capacity somewhat greater than the total cubic capacity of the battery of air receivers. As 2.3 feet of water gives 1 pound pressure, the mean elevation of the tank above the receivers should be $90 \times 2.3 = 207$ feet. There is a large pipe connection from the

bottom of this tank to a horizontal pipe in free communication with the lower ends of all the receivers. No valves of any kind are required, and little, if anything, need be allowed for the fricton of the water in the pipes, it being free to flow in either direction, according to the changes of the volume of air in the receivers. No safety valves are required, and it is impossible to produce any pressure in the receivers greater than that due to the head of water.

The compressed air as it is delivered from the operating compressors does not pass through the receivers, and, indeed, does not enter them at all except when the air production is greater than the consumption at the moment, when the surplus passes into the receivers, driving out and up into the elevated tank some of the water at the bottom of the receivers. When the call for air is greater than the compressor supply then the deficiency is made up by a flow of air from the receivers, the water from the tank displacing it.

The contact of the air with the water does not make it any wetter, as after compression it is quite certain to be saturated with water in any case. In the service for which this air is used, there is no call for "dry" air, as special means are provided for heating the air before it enters the hoisting engines, and moisture would be an advantage rather than otherwise.

Long continued records of the hoists as they had been run by steam made it possible to compute the compressor capacity required, and to adapt the compressors to the work so that they could be operated at the point of best economy.

The plant is unique as it stands, but in the use of the elevated tank it sets an example which, since there can be no monopolizing of the principle, we may expect will in time be widely adopted. For the maintenance of a constant air pressure with considerable storage capacity it seems to recognize and fill a long persisting requirement. The elevations which will give gage pressures of 50, 60, 70, 80, 90 and 100 pounds are, respectively, 115, 138, 161, 184, 207 and 230 feet. These heights can, of course, be secured as well by sinking the receivers as by elevating the tanks, or by a combination of both until the vertical difference is secured.

It is to be noted that no water is consumed or wasted in the operation; it simply flows back and forth out of the receivers and in again as the volume of air in storage increases or diminishes. Why not then dispense with the special elevated water tank and connect direct to a city or other water service where sufficient pressure is maintained, as it usually is? If the water pressure is constant and is somewhat greater or less than the air pressure desired the latter might be adjusted by placing the air receiver above or below what would otherwise be its normal position.—*American Machinist,* with additions by the writer.

AIR COOLING AND MOISTURE PRECIPITATION

By F. E. Matthews.

Before proceeding to illustrate the method of calculating the amount of refrigeration required to cool a mixture of air and water vapor it may be advisable to define terms.

Air is a mechanical mixture of nitrogen and oxygen in the practically constant proportion of 80 parts of the former to 20 parts of the latter, a very small percentage, about 3 or 4 hundredths of 1 per cent., of which is replaced by carbon dioxide. Into this uniform mechanical mixture water vapor enters in widely varying proportions. When the air contains all the moisture that it can hold it is said to be saturated. The higher the temperature of the air the more water vapor it is capable of absorbing before becoming saturated. At a given temperature saturated air always contains a certain fixed quantity of water vapor.

It must be remembered, however, that the temperature of the air does not fix the amount of moisture that it contains except in the limiting case of saturation. In general, air is not saturated, and it may contain different amounts of water at the same temperature as it varies in degree of saturation; or it may contain different amounts of moisture at the same degree of saturation at different temperatures. Since the amount of water that it is possible for air to hold in suspension increases with increasing temperature, and decreases with decreasing temperature, it is evident that the air may or may not contain less moisture after cooling than before, according to whether the cooling is carried below the temperature at which the air becomes saturated.

POUNDS OF AQUEOUS VAPOR IN 1000 CU.FT. OF AIR AT DIFFERENT TEMPERATURES AND PER CENT. SATURATION

At	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
100° F	0.282	0 423	0.056	0 705	0.847	0.988	1 130	1 270	1 411	1.552	1 694	1 83b	1.976	2 117	2.259	2.400	2.541	2.682	2.823
95° F.	0 244	0.366	0 489	0 621	0.733	0.855	0 978	1.100	1 223	1 345	1.467	1 589	1.712	1.844	1.977	2.089	2.201	2.323	2 446
90° F.	0.211	0.316	0.422	0.527	0.633	0.740	0 847	0.951	1 056	1 161	1.267	1.373	1.479	1.584	1.690	1 795	1 901	2.005	2 110
85° F.	0.182	0.272	0.363	0.454	0.545	0 636	0.727	0 818	0 909	1.000	1.091	1.182	1.273	1.364	1.455	1.546	1.637	1.728	1 819
80° F.	0.156	0.234	0.312	0.390	0.468	0 546	0 624	0.702	0.781	0.859	0.937	1.015	1.093	1.166	1.249	1.327	1.405	1.483	1.562
75° F.	0.133	0.200	0.267	0.334	0.401	0.467	0.534	0.601	0.668	0.735	0.802	0.868	0.935	1.002	1.069	1.135	1.202	1.269	1.336
70° F.	0.114	0.171	0.228	0.285	0.342	0.399	0.456	0.513	0 570	0.627	0.684	0.741	0.798	0.855	0.912	0 964	1.026	1.083	1.140
65° F.	0.096	0.144	0.193	0.241	0 290	0.338	0.387	0.435	0.484	0.532	0.581	0.629	0.678	0.726	0.775	0.823	0.872	0.920	0.968
60° F.	0.082	0.123	0.164	0 205	0.246	0.286	0.327	0.368	0.410	0.451	0.492	0.533	0.574	0.615	0.656	).697	0.738	0.779	0.820
55° F	0 069	0 103	0 138	0.172	0.207	0.242	0.277	0 311	0.346	0.380	0.415	0.449	0.484	0.519	0.554	0.588	0.623	0.657	0.692
50° F	0.058	0.087	0.116	0 145	0.174	0.204	0 232	0.261	0.291	0.320	0.349	0.378	0.407	0.436	0.465	0 494	0.524	0.553	0.582
45° F.	0.048	0.072	0.097	0 121	0 146	0 170	0.195	0.219	0.243	0.267	0.292	0.316	0.341	0.365	0.390	0.414	0.439	0.463	0.487
40° F	0.040	0.060	0.081	0.101	0.122	0.142	0.162	0.182	0.203	0.223	0.244	0.264	0.284	0.304	0.325	0.345	0.366	0.386	0.407
35° F.	0.033	0.050	0.067	0.084	0.101	0.118	0.135	0.152	0.169	0.185	0.202	0.219	0.236	0 253	0.270	0.287	0.304	0.321	0.338
32° F.	0.030	0.045	0.060	0.075	0.090	0.105	0.120	0.135	0.150	0.165	0.181	0 196	0.211	0 226	0.241	0 251	0.271	0.286	0.301
30° F.	0.027	0.041	0.055	0 068	0.082	0.096	0.110	0 124	0.138	0.151	0 165	0.179	0.193	0.207	0.221	0.234	0.248	0.262	0.276
25° F	0.022	0.033	0.044	0.055	0.066	0.077	0.088	0.099	0.110	0.121	0.133	0.144	0 155	0.166	0.177	0.188	0.199	0.210	0.221
20° F.	0.017	0.026	0.035	0 043	0.052	0.061	0 070	0.079	0.088	0.096	0.105	0.114	0.123	0 132	0.141	0.149	0.158	0.176	0.176.
15° F.	0.014	0.021	0.028	0.035	0.042	0.049	0.056	0.063	0.070	0 077	0.084	0.091	0.098	0 105	0.112	0.119	0 126	0.133	0.140
10° F	0.011	0.016	0.022	0.027	0.033	0.038	0.044	0.049	0.055	0.060	0.066	0.071	0.077	0.082	0.088	0.093	0.099	0.104	0 110
+5° F.	0 008	0.012	0.017	0.021	0 026	0.030	0.035	0.039	0.043	0.047	0.052	0.056	0.061	0 065	0.069	0.073	0.078	0.082	0 087
0° F.	0.006	0.009	0.013	0.016	0.020	0.023	0 027	0.030	0.034	0.037	0 041	0.044	0.048	0 051	0.055	0.058	0.061	0.064	0.068
—5° F	0.005	0.007	0.010	0.012	0.015	0.018	0.021	0.023	0.026	0.028	0.031	0.034	0.037	0.039	0.042	0.044	0.047	0.049	0.052
—10° F	0.004	0 006	0 008	0 010	0 012	0.014	0 016	0.018	0.020	0.022	0.024	0.026	0.028	0 030	0.032	0.034	0.036	0.038	0.040
—15° F.	0 003	0 004	0 006	0 007	0 009	0.010	0 012	0 013	0.015	0.016	0 018	0.019	0.021	0 022	0 024	0 026	0.028	0.029	0 031

The accompanying table shows the amount of vapor in pounds per thousand cubic feet of air at different degrees of saturation at different temperatures. At 100 degrees Fahrenheit and 100 per cent. saturation, for example, 1,000 cubic feet of saturated air will contain 2.82 pounds of water vapor, while at 75 degrees Fahrenheit, the amount is only 1.33 pounds, or less than one-half that quantity, and at 15 degrees Fahrenheit, it is still further reduced to about one-tenth of what it is at 75 degrees Fahrenheit.

In the general case, air cooling involves cooling not only the mechanical mixture of oxygen and nitrogen, but a large quantity of water vapor as well. If the air contains sufficient moisture so that the cooling brings it to the point of saturation, the heat that must be abstracted from the water vapor will be only that represented by the specific heat of the vapor and the number of degrees cooled through. If it is cooled below the point of saturation, as usually happens in cold-storage practice, not only the specific heat of the vapor but the latent heat of that part of the vapor precipitated as well must be removed. Generally the process is carried still farther and the precipitated moisture is chilled to the freezing point and finally frozen, when not only the specific heat of the liquid but the latent heat of fusion is involved. If the ice is cooled to a lower temperature the specific heat of the ice is also involved.

It is required, for example, to cool 2,000 cubic feet of air per minute from 80 degrees Fahrenheit to 36 degrees Fahrenheit. In the following calculations it is assumed that the amount of air to be cooled is 2,000 cubic feet before it is cooled, and not, as it might be construed to mean, 2,000 cubic feet of cooled air.

For the sake of simplicity the air is assumed to be dry.

Dry air at 80 degrees Fahrenheit weighs 0.0731 pounds per cubic foot; 2,000 cubic feet would weigh, in pounds, 146.2; the specific heat of air is 0.2377; B.t.u. required to cool 2,000 cubic feet 1 degree Fahrenheit, 34.75; B. t. u. required to cool 2,000 cubic feet 44 degrees Fahrenheit, 1,529.

One ton of refrigeration is sufficient to dispose of heat at the rate of 288,000 B.t.u. per 24 hours, or (dividing this number by 1,440, the number of minutes in 24 hours) the equivalent rate per minute is 200 B.t.u.

On this basis, the cooling of 2,000 cubic feet of air per minute from 80 degrees Fahrenheit to 36 degrees Fahreheit would require the expenditure of

$$1{,}529 \div 200 = 7.64 \textit{ tons.}$$

of refrigeration.

Had the requirements been for 2,000 cubic feet of cooled air, the amount of refrigeration needed would have been 8.36 tons, the difference being accounted for by the difference of weight per cubic foot of air at 80 degrees Fahrenheit and 36 degrees Fahrenheit, respectively.

Cold storage and refrigerating warehouses in New York State have been placed under the jurisdiction of the State Commissioner of Health by an Act recently passed by the Legislature. Besides giving the power of inspection and supervision, the Act also limits the period of storage of any kind of food to 10 months, except that butter may be kept in cold storage for 12 months.

SAFETY AND ECONOMY, OR THE REVERSE, IN COAL MINING

The following is a portion of a letter by Mr. S. M. Sexton, Blossburg, Tioga county, Pa., in a recent issue of the *Scientific American*:

The lower drift at Arnot, Pa., has been worked since 1866. There was seldom less than 800 miners employed in it. The workings extend over 23,000 acres and 96 per cent. of the coal is taken from the workings. In the forty-five years the mine has been worked but six men have lost their lives while digging coal, and an accident is a very rare occurrence. That I term the correct method of working a coal mine.

In Sullivan, Indiana, a coal mine has been worked seventeen years. About 150 miners are employed. The workings extend over 600 acres. An average of seven men have been killed in it each year, while accidents are of almost daily occurrence. That I call the incorrect method, for less than 60 per cent. of the coal is taken out.

The method of working at Arnot, Pa., is this: All coal is both undercut and sheared by pick or machine; then a few ounces of powder brings down the coal without shattering the strata above, so that when the outcrop is reached the pillars can be drawn, thus leaving but three or four per cent. of the coal behind.

The freedom from death and accident is due to this: When the miner reaches his room he immediately takes his lamp from his head and cautiously raises it once in a while to see if the flame will denote the presence of firedamp. If so, he does not blow it out, but slowly puts it down on the ground and extinguishes the lamp by placing his coat over it. When the miner reaches the "face" he takes a pick and sounds the roof to find out if there is any loose rock overhead. If so, he either wedges it down or sets a prop under it. Though the mine is full of coal dust no dust explosion ever took place in it.

At Sullivan, Indiana, the coal is "shot from the solid." Little or no under-mining is done. Each miner uses from five to ten pounds of dynamite or an equally strong explosive each day. This not only loosens the coal, but shatters the roof also, so that if a vein of coal is above the one worked it is extra hazardous. It does more. It causes the almost daily accident and the loss of about 40 per cent. of the coal in the mine. It is rarely possible there to draw the pillars. So the net result is the loss of 40 per cent. of the mine worked, the almost entire loss of the vein above and a continuous maiming and killing of the miners.

Consider this matter in another way: Supposing a half ton or more of dynamite were exploded in five and ten-pound charges in the streets of a city within one hour. What would be its effects in the open? Apply this, then, to what must be the effect of the explosion of a similar amount in a mine where the effect of the explosion has but a single direction to expand. All this is to take place within the area of fifty acres.

The method used in Indiana is in vogue all over the West. It is wasting, criminally wasting, a large percentage of the most valuable of nature's gifts and causing a wholesale slaughter of men. I edited the national official organ of the coal miners for seven years, and my observations, extending practically all over the coal field, taught me that there was but one way to prevent the slaughter of miners and the criminal waste of coal, to wit: To make it a penal offense to shoot coal from the solid or to attempt to get it without undercutting and shearing the "shot" with either pick or machine.

What would be the result? But one-tenth of the powder would do the work; there would be no dust explosions, for little dust would be made; the strata above would be practically unharmed, thus preventing the killing and maiming of miners and securing over 90 per cent. of the coal.

That this is so is again illustrated by coal regions separated only by county lines, Allegany County, Maryland, where the method used is similar to that used in Arnot, Pa., with similar results, and Allegheny County Pa., where the Indiana method is used and the same results ensuing.

When I stated these things in the miners' organ the operator would sneer at them because he wanted to get the greatest amount in the shortest time regardless of the wrong he was doing to the country and the injury to future generations. Many miners indulged in somewhat heated criticisms of myself, for they too, wanted to get the most for the least.

At Penticton, B. C., a hydro-electric plant is being installed with a static hydraulic head of 2,115 feet.

DEVICES OF VARIOUS PNEUMATIC INTEREST

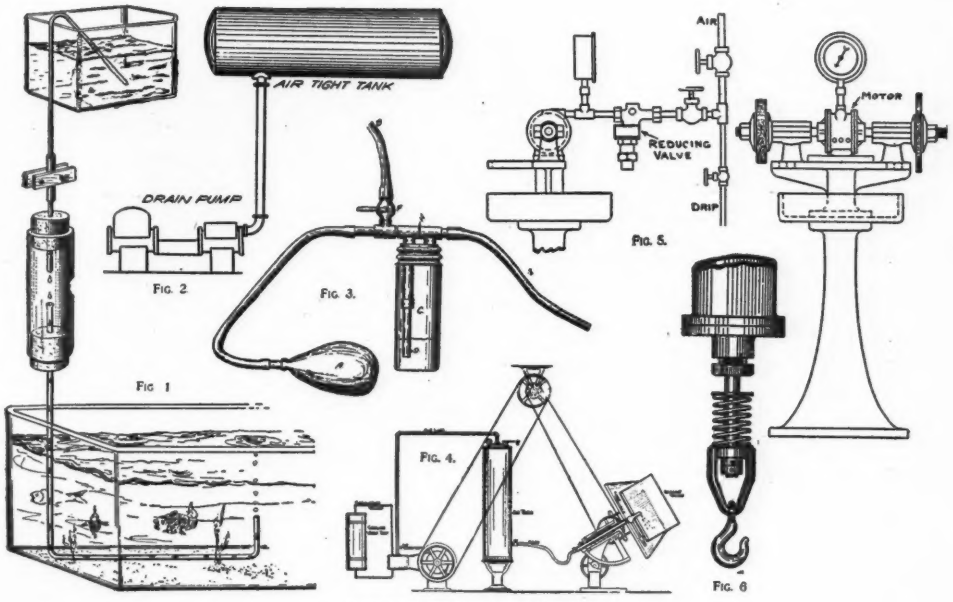
Pneumatic apparatus, or devices with which the air has something to do, are appearing constantly in all the technical papers. They are indeed so familiar that it is not worth while to call attention to them unless they are in some particular a little out of the usual line. In the cut upon the opposite page we have grouped together several clipped from recent exchanges. It is probable that each will be of interest to some of our readers. Fig. 1, an aerating apparatus for a fish tank is from *Popular Mechanics.* Place immediately above the fish tank a small reservoir. Procure a siphon tube 3/16 inch in diameter and a short tube of about 5/8 inch in diameter, the latter to serve as an air chamber. In the side of the chamber file a hole; fit each end of it with a cork. Through the upper cork pass a short length of glass tube, and connect this with the end of the siphon tube by a bit of rubber tubing. On this rubber tubing mount a regulator, which will govern the amount of water flowing through the siphon tube. The regulator may be made of two small pieces of wood arranged to be clamped together by means of a pair of screws, so as to squeeze the rubber tube, and thus reduce the flow of water through it. Through the lower cork of the air chamber run a glass tube, as indicated in the drawing, leading to the center of the fish tank. The upper end of this tube should be slightly flared, to form a funnel-shaped mouth directly under the upper tube. In operation, the regulator should be adjusted to cause the water to drip slowly from the siphon. The dropping water will fall into the mouth of the lower tube, and the air between each drop of water will be imprisoned within the tube. The alternate drops of water and air spaces will then travel through the tube to the fish tank, spreading through the water of the fish tank and thoroughly aerating it.

Fig. 2 is not a pneumatic device at all. It is from the *Practical Engineer* and merely graphically propounds a question which no one can answer without at least thinking of and referring to the air. If the suction pipe of a pump is connected to the under side of an air-tight tank filled with water and at a higher level than the pump, as shown in the sketch, can the water be drawn from the tank?

Fig. 3, a portable instantaneous leak detector, is from the *Progressive Age.* It normally has to do with gas, but is equally applicable to air piping at light pressures. It will immediately indicate the smallest leak in a closed system to which the apparatus may be attached. A mouthpiece or pressure tube "B" is connected through a cock "F" with both an elastic rubber bag "A" and with a glass tube "D" which projects below the water in the air-tight bottle "C." The joint at "H" is blank and the tubing connects the system to be tested with the air chamber above the water in bottle "C." In operation, pressure is applied at "B" with cock "F" open. It immediately equalizes throughout the system. The cock "F" is then closed and if there is any leak, the pressure beyond "I" will be reduced and the pressure from the elastic bag will cause bubbles to pass through the water in the jar "C" at a rate proportional to the size of the leak. This apparatus is very handy in the shop for testing for leaks in fixtures, tanks, etc., while out on a job it is especially adapted to test house-piping.

Fig. 4, from *Machinery,* shows a tilting sand blast tumbling barrel for cleaning castings, built by the Globe Machine and Stamping Company, Cleveland, Ohio. In this apparatus, as will be seen, are combined the two methods of cleaning, namely, tumbling and sand blasting, and the result is an embodiment of the simplicity and cheapness of the tumbling barrel with the efficiency of the sand blast. The operation of the outfit is as simple as that of an ordinary tumbling barrel. The contents can be watched closely while the barrel is in operation and the tilting feature allows the barrel to be readily emptied or adjusted to give more or less violent tumbling. The sand blast barrel requires no large sand reservoir or conveying machinery. The sand is drawn by suction from the sand chamber and discharged against the work; it then drops through the perforations of the barrel into a sand chamber to be used over again. This barrel is not suitable for large castings, but for small work which can be readily tumbled. The outfit is inexpensive and has proved satisfactory in service. One man can easily operate from six to ten barrels.

Fig. 5, from *Canadian Machinery,* shows a small double emery grinder sketched in the Frog and Switch shop of the G. T. R. at



VARIOUS PNEUMATIC DEVICES.

Toronto. It is driven by a small air turbine or motor, mounted on the shaft, between two emery wheels. A reducing valve on the air line brings the pressure down to about 40 pounds per square inch, the pressure gauge being mounted where it can be easily read. It is not claimed that this is a highly economical method of driving an emery wheel, but where, as in this case, there is no belt or electric drive available, it serves the purpose admirably. For the sake of clearness, the emery wheels have been omitted in the end view. An idea of the scale of the drawing may be gathered from the fact that the thinner of the two wheels is 10 inches diameter, and that the centre of the spindle is 39 inches from the floor. There would seem to be here a possibility that the wheels might attain a dangerous speed when there was no grinding friction to act as a brake.

The air hoist device, Fig. 6, is also from *Canadian Machinery*, sent in by a contributor. When air hoists are carelessly operated the top cylinder heads are sometimes hit by the piston so hard as to break something. The coil spring shown in the cut is intended to check the piston before it strikes. The spring is made of 1-4 or 5-16 in. square steel. There should be a washer both above and below the spring and as big as the outside diameter of it.

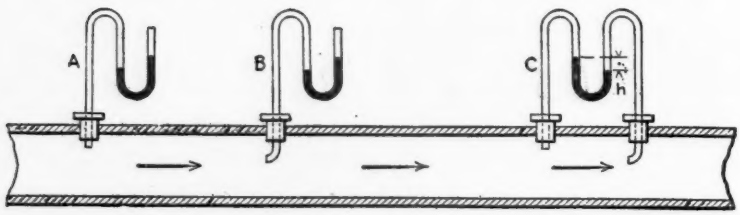
MEASUREMENT OF AIR VELOCITIES

By F. G. Hechler.

In heating and ventilating work it is often necessary to determine the amount of air supplied by a fan. The volume of air is expressed in cubic feet ,and as it is nearly always conducted from the fan through a duct either circular or rectangular, the cross-sectional area of the conduit and the velocity of the air through it should be known. The product of the area is square feet by the velocity in feet per minute gives the cubic feet supplied per minute.

The velocity may be determined in several different ways, though the most common method is by the use of an anemometer, a small-vaned instrument similar to a windmill wheel. The wheel is connected with a recording mechanism by the use of which in connection with a stop-watch, or even an ordinary watch, the speed of the air past the vanes may be determined. Its convenience is the only thing to recommend it as an anemometer, however, as its readings are subject to large and uncertain errors.

It is well known that the velocity of air in a pipe line is not the same at all points, being greatest at the center and least at the sides, where friction against the surfaces retards it. For a circular pipe the law of vari-



PITOT TUBE TO MEASURE VELOCITY OF AIR

ation is usually taken to be a parabola; the air moving in concentric layers with the average velocity at a point two-thirds of the radius from the center. This variation in velocity may partly account for the uncertain results obtained with an anemometer, and it is evident that an instrument properly calibrated may give too high a reading if held at the center of a large duct.

A better way to determine the velocity, and one which gives much more reliable results, is to use a Pitot tube. To make clear the principles on which the use of this instrument is based, its use for determining the velocity in a water main will be considered. Water is a more concrete substance than air and hence it is easier to deal with it; but exactly the same laws apply in regard to the velocity of air as hold for water.

A pressure gage connected to a pipe line will show a higher pressure with no flow than when the water is in motion, and the faster the flow the lower the pressure shown by the gage. When there is no flow the gage shows the total or static head; when the valve is opened and flow occurs a part of this head is used up in causing the water to flow: In other words, a "velocity head" is necessary to produce motion, the remaining head shown by the gage being the "pressure head." If the pipe were perfectly smooth and there were no friction losses, the sum of the velocity and pressure heads would always equal the static head shown when there is no flow. The friction losses are variable and not easily measured, but the Pitot tube gives a ready method for finding the velocity head, and from that the velocity, as shown later.

If a tube be inserted in a pipe line, as at *A*, Fig. 2, with its inner end parallel to the axis of the pipe and hence to the direction of flow of the liquid or gas, and the outer end connected to a U-tube filled with water or mercury (depending on the pressure to be measured), the difference in the height of the two columns represents the pressure head expressed in inches of water or inches of mercury. If a second tube be placed, as at *B*, with its end bent at right angles so that it is perpendicular to and faces the flow of the stream, its manometer tube will give both the pressure head and the velocity head. If then the difference between the readings of *B* and *A* are taken, the velocity head producing flow is obtained. For convenience, these two separate gages are usually combined into one, as shown at *C*. Here the tube at the left, similar to *A*, tends to show the pressure head; the tube at the right, similar to *B*, shows the pressure head and the velocity head. In other words, connecting the tubes in this manner automatically performs the above subtraction and the reading of this gage represents the velocity head.

After the velocity head is found, the velocity is calculated by the formula

$$v = \sqrt{2gh},$$

where

v = Velocity in feet per second;
h = Velocity head in feet;
g = Acceleration due to gravity in feet per second = 32.2 feet.

If the manometer contains water and the velocity of air is being determined, then the head must be changed from inches of water to feet of air by multiplying by the ratio of the density of water to that of air. To do this the temperature must be known, as the weight of a cubic foot of air and of water depends on the temperature. To illustrate, assume that the manometer reading *h*, in Fig. 2, is 1 inch of water and that the temperature of the water and of the air is 60 degrees Fahrenheit. From tables the weight of 1 cubic foot of water at 60 degrees is 62.37 pounds and of 1 cubic foot of air at the same temperature is 0.0764 pound, or the height of a col-

umn of air in feet to represent the same pressure as 1 inch of water would be

$$\frac{62.37}{0.0764} \times \frac{1}{12} = \frac{816.4}{12} = 68.03 \textit{ feet}$$

Using the equation

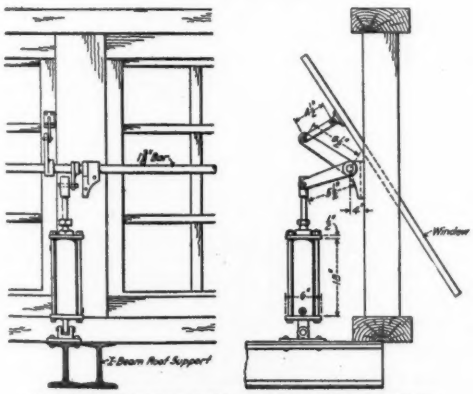
$$v = \sqrt{2gh} = \sqrt{2 \times 32.2 \times 68.03} = 66.2 \textit{ feet per second}$$

For any other temperatures, or if mercury is used in the place of water, the proper weights per cubic foot would have to be used. —*Power* (abridged).

THE WINDOWS WERE SUCKED IN

At a certain foundry a positive blower is used to supply draft for cupolas. It is located in a separate closed room, 12x16 feet, which has three glass windows 3x6 feet. The door is kept locked so that nobody can go into the room to loaf. The windows were the only way the room could be ventilated. One day the windows were closed tight. The man who had charge of the blower turned it on, thinking everything was all right, locked the door and went back to his work. In a short time there was a crashing of glass and everybody thought a terrible accident had happened.

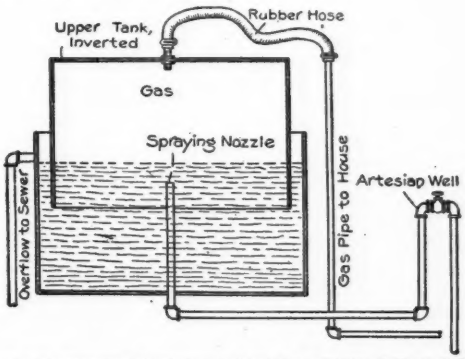
The man quickly opened the door and to his amazement the three windows were on the floor, all in pieces. After the blower had run a little while it produced a partial vacuum in the room; hence the windows were simply sucked in.—*American Machinist.*



APPARATUS FOR OPENING AND CLOSING SHOP WINDOWS

By T. M. Dryden.

An arrangement for opening and closing shop windows by compressed air is shown in the accompanying illustration. It consists of an air cylinder 18 in. long, made of 3½-in. pipe, a long 1⅜-in. bar and the necessary connections. The cylinder sets on a pin which allows it to swing when turning the rod. The rod extends the length of the shop, being connected to the windows by the lever arms as shown. There are⅜-in. air connections at the top and bottom of the cylinder to lower and raise the piston when desired. This arrangemen is used in the shop power house of the Central Railroad of New Jersey at Ashley, Pa. It operates sixteen windows, and without a doubt could handle three or four times as many. It was designed by Frank P. Meekins, foreman of the car wheel shop.—*Railway Age Gazette.*



GAS FROM ARTESIAN WATER WELLS

In the artesian basin of North Dakota there is a stretch, about 10 miles wide and 25 miles long, in which the water contains a quantity of natural gas varying from 20 to 50 cubic feet per hour, flowing out with the water at a pressure of from 25 to 65 lb. per square inch. Many farmers having an artesian well with gas are utilizing this gas to heat and light their homes. The separation of the gas from the water is effected by means of two tanks, one inverted into the other as shown in the sketch. The gas collects in the upper tank, and, as the pressure rises with accumulation, this upper tank rises until it can hold no more, the gas thereafter escaping around the lower edges into the air. When, however, the gas is used, the weight of the tank forces it through the hose at the top and the pipe connected therewith to the fixtures. One town in the artesian district has a well producing gas enough to run two 25 h. p. engines running a dynamo to light the whole town, besides furnishing water for all needs.

WONDERS OF WATER

The action of water is far more than a purely mechanical one. Water wets things and other liquids do not. Benzine, for example, although it may saturate a fabric, does not "wet" it. It has been found that most chemical reactions, in which apparently water is in no way concerned, will not proceed in the absence of water; so that water must possess some action peculiar to itself which is not yet thoroughly understood.

Water probably approaches closer to the universal solvent that the ancients dreamed or than most people suppose. There are very few things which will not dissolve to some extent in water, and distilled or rain water, which is free from any dissolved mineral matter, possesses remarkable solvent powers. If placed in a glass or earthenware vessel, it rapidly attacks the glass or the glaze of the earthenware, dissolving out the alkali. If placed in metal vessels or pipes, the metal, if it be iron, lead or zinc, is quickly attacked by the water, with probably the help of the dissolved air which it contains. This powerful solvent action of what is commonly called "soft" water, is alone a good reason for the launderer to use it as much as possible.

Another effect of this powerful solvent tendency of soft water is that as it passes through the soil, carrying, in addition to its own solvent powers, some carbonic acid from the air and some of the humic acid from the decomposing vegetable matter in the soil, both of which help it to attack the rocks, it dissolves out a large variety of mineral substances. The most common are sodium chloride (common salt), magnesium chloride and calcium chloride, calcium sulphate (gypsum), magnesium sulphate and calcium carbonate (chalk and limestone). In addition, some waters contain peaty matter derived from bog moss on the hills, and iron.

All or any of the substances just mentioned are undesirable in the washing machine, as, with the exception of the peaty matter, they combine with the fatty acid of the soap, rendering it useless from the launderer's point of view, and thereby causing a large waste, as well as the bad color, streaks and other blemishes due to the lime soap already referred to. Another objection to the presence of lime in the water used in the washing machine is that, although most of it goes into combination with the soap or is thrown out in a loose form by the soda, yet an appreciable amount very frequently is deposited in a crystalline form in the fibres of the linen, where it accumulates with every wash until the amount present is quite appreciable. These sharp crystals of carbonate of lime rapidly assist the ordinary process of wear and tear, and the life of the article becomes exceedingly short.—*National Laundry Journal.*

DYNAMITE DISAPPOINTMENTS

A young man employed on some road construction work in Virginia saw a pail standing by the road. Some one told him that the pail contained dynamite, so to show that he wasn't to be bluffed that way he kicked the pail. The dynamite exploded, and the unexpected happened, for the only injuries sustained by the young man was the loss of both shoes and the greater part of his pants. In another case three men were digging a well, and after they had got down about 5 feet, they struck some rock which required blasting. A charge of dynamite was put in, and the fuse touched off. For some reason the charge did not explode, and after waiting some time one of the men crawled up to the well to see what was the matter. Just as he had his head well over the hole the dynamite let go, the only result being that the man lost the skin from the very tip of his nose.

THE FRASCH PROCESS

The Frasch process, invented by Herman Frasch, of Cleveland, Ohio, and extensively employed in Louisiana, whereby practically pure sulphur is obtained directly from wells is as follows: A well is driven in much the same manner as a gas or oil well is sunk, and into it are placed several concentric lines of pipe. Superheated water, introduced through the outer pipe, melts the sulphur, which may be several hundred feet below the surface. Hot compressed air is then forced through the smallest of the pipes. This forms an aerated emulsion with the molten sulphur, which is forced out by hydrostatic pressure between the remaining pipes and discharged in a purified form into large vats where cooling, solidification, and feeding go on simultaneously. The sulphur is then broken up, shipped by rail to the Gulf coast, loaded on ships by machinery, and transported to Eastern coast ports.

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CONTENTS

Tunnel Driving in the Alps..... 6187
Varying Currents of the Upper Air.... 6192
Pneumatic Hammers for Breaking Street Pavements 6193
Squandering the Principal..... 6196
Emergency Pneumatic Pumping..... 6196
Unwatering a Mine with the Air Lift.. 6197
Powerful Effects of Sound..... 6198
Oxygen Consumed by a Lamp..... 6199
New Development in Compressed Air Storage 6199
Air Cooling and Moisture Precipitation 6201
Safety and Economy in Coal Mining.... 6203
Various Pneumatic Devices..... 6204
Measurement of Air Velocities..... 6205
Opening and Closing Shop Windows.... 6207
Gas from Artesian Water Wells..... 6207
Wonders of Water..... 6208
Dynamite Disappointments 6208
The Fraech Process of Sulphur Mining 6208
Independence in Mine and Quarry..... 6209
The Disappointing Air Receiver..... 6210
Constant Volume with Varying Pressure 6212
Steam or Air for Atomizing Oil..... 6212
Notes 6213
Patents 6215

INDEPENDENCE IN MINE AND QUARRY

Independence is the unique ideal. It is a thing so desired and longed for that the most strenuous and protracted exertions of earnest men and the most sweeping sacrifices of all other things have from time immemorial been made to secure it. The value is in the thing itself, and is so intrinsic and enduring that too much can never be paid if necessary to secure it. Often it comes cheaply or for nothing at all, but the value inheres just the same.

Independence applies and has its value in business and industry just as much as in sociology, and ostensibly is as constantly sought for, but is not always recognized and appreciated and appropriated as soon as it comes in sight and reach. This is not to be wondered at just now, as the work of the most pronounced and efficient of modern industrial emancipators, which electricity surely is, has not been all and straigihtly for the fostering of general and permanent independence. Electricity is a wonder in power transmission, and by its alertness and adaptability has driven out some of the most established of old-time "facilities." Especially has it driven out, among other things, the small individual steam-operated apparatus, doing the same work of pumping and hoisting and hauling more readily, efficiently and cheaply.

Before, however, electricity began to show what it could do and how well it could do it, by actual performance in various fields, compressed air had become very firmly established in mines universally, and in quarries quite extensively, for the driving of the rock drills, so that in many cases in recent years it has happened that steam and compressed air and electricity have all found employment side by side where one of the agents could and should have done it all.

This is a kind of thing which is not to be tolerated in these days, and if there has not been a formal declaration of independence, the work of simplification, which is emancipation, has begun. One power transmitter instead of three is what we are to aim at. It has not been a difficult thing to supersede direct live steam for scattered and isolated service. Its wastefulness and inconvenience as compared with either air or electricity is conclusive at once against it, and it goes.

As between air and electricity the relative claims are not so easily settled, and circumstances may sometimes cause the retention of both. The one which apparently refuses absolutely to be ignored or rejected is electricity It must be had at least for lighting, and for long-distance transmission of power it has made the field its own. In many plants in these days it must be installed for these features alone, and if it could be also applied to the entire service in any particular plant, instead of employing also one or both of its chief competitors, that would be real independence for the proprietor.

For the driving of rock drills and allied reciprocating apparatus, especially the channeler for quarry work and the radial-axe coal cutter, which also is a channeler, air has, up to quite recently, monopolized the job. All at once comes along the electric-air device, which, by an adroit mechanical compromise, entirely changes the situation and makes the electric current fully competent for the last employment in mine or quarry which compressed air has claimed as exclusively its own. It is the independence which the electric-air device gives as to choice of motive power which constitutes its supreme excellence. It emancipates the employer as completely as may be from the tyranny of his servants and he may now make his arrangements with the one instead of the three. The electric-air drill or channeler, or the electric-air radial-axe coal cutter may still call itself an air-operated tool if it will, but only a wire connects it with the powerhouse.

THE DISAPPOINTING AIR RECEIVER

By Frank Richards.

In speaking here of air compressors, and more particularly of the air receivers which always accompany them, the writer has in mind those installed for service sufficiently permanent to warrant the provision of safe and economical working conditions. This includes air compressors which are installed in most of the plants of any considerable capacity. Compressed air is used as a necessity for operating rock drills, when sinking shafts, driving tunnels, and in general mining work, etc. It is also used as a time and money saver in still greater volume for a much wider range of service. Every extensive manufacturing plant must have its compressed air supply distributed throughout its works; for the larger engineering operations, such as dams and waterworks construction, and in the most extensive quarries, compressed air is superseding the isolated steam-operated pumps, hoists, shovels, stone crushers, concrete mixers, etc.

In all these extensive lines of air service, and, in fact, in all air practice, it makes a great difference as to the condition of the air when used, and especially as to the moisture which may be carried in it, much inconvenience and loss of time occurring when the air is not kept dry and clean. There is always a pretence made of attending to this necessity. Who would think for a moment of installing an air compressor without a good sized air receiver as close to it as possible? The man who would set up an air compressor without an air receiver would lose all his respectability among engineers. Respectability has, perhaps a good deal more to do with the installation of an air receiver than anything else.

SMALL STORAGE CAPACITY.

If you were to ask the whys and wherefores of an air receiver, you would probably be told that "everybody always uses them." If you pressed the matter still further, you would most likely be told that the receiver is needed for the storage of air and the steadying of the flow. Well, the total capacity of the air receiver usually installed with an air compressor does not exceed the output of the compressor for one minute. If the compressor is running continuously, and if the air is being used as fast as it is delivered, the apparatus driven by the air must come to a standstill within a single minute. So it can be readily seen that the air receiver as a storage adjunct is of little value.

RECEIVERS DO NOT COOL THE AIR.

Builders and sellers can afford to have you pooh-pooh the storage service of air receivers, but they will still assert the two-fold need of them for cooling the air and for getting rid of the moisture in it, the presence of the latter being the most serious objection to the air in use and the cause of the most trouble. Now as to the cooling of the air, how can the receiver do it? To cool the air as it comes from the compressor, there must be a cooling surface or material for the air to come in contact with, and to which it may impart its heat. The air receiver, however, is a plain

cylindrical shell with no pretence of a cooling device or any arrangement of the sort within it, and the air merely passes through it hurriedly, emerging at the other end practically as hot as when it entered, giving up its heat more or less rapidly to the inner surface of the pipes through which it travels, for which cooling effect the pipes and not the receiver should have the credit.

COMBUSTION IN THE RECEIVER.

It is a curious fact that the air receiver, so far from being an air cooler, has often been transformed into a combustion chamber. Numerous authenticated instances are cited of receivers which have become red-hot while compression and transmission were going on, and flames have been emitted at the ends of the pipe at a considerable distance from where the air was "stored;" receivers have also sometimes exploded, which is much worse. When single-stage compressors are worked up to desirable service pressures, say 80 to 90 pounds gage, the temperature of the air discharged (water jackets having very little effect upon it) is high enough to volatilize the lubricating oil used; this oil-gas mingling with the air in such proportion as to form an explosive mixture, may be diffused through the receiver and into the pipe lines. Then if there is a sufficient increase of temperature to cause spontaneous ignition, or if there is a friction spark, disastrous and often fatal explosions result. It is well known that for the formation of an actively explosive mixture of oil-gas and air, the two constituents must be mingled in certain proportions, the limits of which, in either direction, have been quite precisely determined, and if either the oil-gas or the air be in excess when ignition occurs, there is no sudden explosion, but simply the active combustion which makes the recevier and air pipes hot. Although this is sufficiently alarming when discovered, it may be assumed that the danger of explosion is past.

If lubricating oil is used to excess in the air cylinder, it may accumulate in pockets or upon the horizontal surfaces for a considerable time, and when favorable conditions occur it may take fire and burn from the surface, just as the soot in a chimney takes fire. The activity of the combustion is not to be wondered at when it is remembered that on account of compression, the quantity of oxygen per unit of volume has increased six-fold or more, according to the pressure carried.

THE RECEIVER DOES NOT DRY THE AIR.

While the air receiver is not, thus, a cooler of the air, it also is not, for the same reason, an abstractor of the moisture in the air, this being the most desirable service which it could render, and which it has been too readily assumed to do. It is well enough understood that atmospheric air—free air—always carries moisture and also always has capacity, or as we might say appetite, for more, up to the point of saturation, when its avidity suddenly ceases. The moisture-carrying capacity of the air rises very rapidly with its rise in temperature, and diminishes, but not so rapidly, with rise of pressure. As the pressure must always be at the highest point just when the air is leaving the compressor, if we can then reduce its temperature to the lowest point, the air will be in a condition to surrender so much of its moisture that none will be found later to cause trouble, when lower pressures and perhaps higher temperatures are reached further along the line. It being thus sufficiently evident that the best place for drying the air is as near the compressor as possible, the first requisite is an efficient cooler or, rather, aftercooler for the air.

The air receiver, as has been said, has never been a cooler of the air, and the builders are now testifying to this fact by the number of aftercoolers they are offering. The best of these are highly efficient, and the air after going direct from the compressor and through the intercoolers is in the precise condition desired—that is, of high pressure and low temperature—for the surrender of its moisture. For the important service which the aftercooler may render, nothing could be expected to work more cheaply. There is only the first cost of the apparatus and connections, and then a sufficient supply—not large—of free running water.

Now, surely the air receiver is available for depositing the excess moisture which the aftercooler has liberated, and for sending forth the air sufficiently dry for all subsequent employment. Unfortunately, the typical air receiver still persists in its inefficiency, and the air passes through and out of it wet, or carrying a considerable amount of free moisture. It is to be remembered that when the saturation point is lowered by the lowering of the

temperature of the air, and there is a relinquishing of the surplus moisture by condensation into water, that water still remains in the air, as mist or fog, and what is then needed is a separator. Any of the separators which are successful in drying steam are equally efficient in taking the liberated water out of the air, when it is in the condition here spoken of. The efficiency of such separators is due to the habit which water has, and which liquids like alcohol, benzine, etc., do not possess, of wetting or clinging to the surfaces with which it comes in contact. A constant repetition of this wetting process causes the water to drip or flow off and accumulate in pockets provided, from which it may at intervals be drawn off.

IMPROVE THE AIR RECEIVER.

An air receiver of the common type, preferably horizontal, if merely provided with a series of baffle-plates (which might be added without much additional cost) would be an efficient separator, provided that the air passing through it were in the prescribed condition of high pressure and low temperature. Indeed it would seem to be quite possible to combine in one apparatus the two functions of cooling the air and separating the freed water from it, and it might also be made large enough to constitute a storage capacity equal to that of the plain air receiver. It would seem to be almost an absurdity to be still installing the latter.—*Machinery,* with some additions by the writer.

CONSTANT COMPRESSED AIR VOLUME WITH VARYING PRESSURE

In general compressed air practice the usual requirement is the maintenance of a constant pressure while furnishing a varying volume, but it appears that the successful operation of water-gas sets depends primarily upon constancy of volume of air supplied the generator, and not upon constancy of pressure. By furnishing a constant volume at high pressure the blast period is cut down, permitting a longer "making period," which results in a material increase in the capacity of the gas generator.

If each gas generator had its own individual blower this would bring the task of governing it back to the ordinary method of governing the stationery engine by the maintenance of constant speed, this giving practically the volume required. When, however, generators take their air from a common blower installation the case is different. To maintain this constant volume under such conditions, regardless of the varying resistances of the fire, a gate or apertured disc will serve, although the Venturi tube is coming into general use. The constant volume is a result of maintaining a differential of pressure through the tube; in other words, if the drop of pressure is kept constant, the volume per any given unit of time will be constant, therefore a valve is placed in the tube to open or choke the pipe as much as is necessary to maintain the constancy in the pressure drop.

To operate the water gas blowing set for these conditions, the speed is maintained to deliver the maximum volume required at a pressure which will drive the desired volume through the fire, regardless of the existing back pressure due to clinkering, etc. To run a blower at such high speed requires in the case of steam driven set that the turbine be developed for this special service, capable of giving a blast pressure considerably over 30 inches W. G. In some recent tests with very large blowers, over 40 inches W. G. was maintained.

STEAM OR AIR FOR ATOMIZING FUEL OIL

By A. M. Hunt.

In order that petroleum may be burned with complete combustion, it is necessary that it be either gasified or injected in the form of a spray into the furnace in which it is burned. The general practice is to deliver the oil to the burner under head and then nebulize it, using air or steam for the latter purpose. Most fuel oils are of a viscous character and are generally preheated in a heater using the exhaust steam from the pumps which handle the oil; this greatly reduces the viscosity. The burners should be so designed that the relative areas of openings for oil and the atomizing medium can be maintained, or, if they become enlarged by scoring, that adjustment can be readily and inexpensively made. A considerable number of tests examined by the author show that an average of 4 per cent. of the steam evaporated by a boiler is required for atomizing the oil fuel (minimum, 2.39 per cent.; maximum, 7.4 per cent). In designing a plant a con-

sumption of 5 per cent. should be assumed. In operation if the amount required is much in excess of 3 per cent., it may be concluded that the condition can be bettered.

In certain metallurgical and industrial operations, especially where high temperatures are desirable, the use of air under pressure for atomizing the oil is to be preferred. In a rotary cement kiln, 7½ ft. diam. by 125 ft. long, producing 500 bbl. of clinker daily with a single burner delivering 4 gal. oil per min., the air used—at 80 lb. pressure—was 25 per cent. of the weight of the oil atomized. A reverberatory copper matting furnace, hearth 80 × 17 ft., with roof arch 39 in. above the surface of the bath on the hearth, required 36,472 lb. oil for smelting 182 tons. The air was supplied by a Connersville blower at 9 lb. pressure, and 1 lb. air was required for each 2 lb. of oil burned. A manufacturer gives the following data: For marine boilers allow 0.2 cu. ft. of free air for each boiler H.P., the air being supplied at about 25 lb. pressure. In burning sewer pipe, about 5 cu. ft. of air per min. is required for each burner using 5 gal. of oil per hour. A 10-cu. ft. compressor running at 20 lb. pressure will supply air sufficient to atomize the oil fuel required by a boiler for heating a small apartment house by steam. A compressor for a 2500-H.P. boiler installation was designed to furnish, at full capacity, air weighing 55 per cent. of the weight of the oil atomized.—Condensed from *Journal of Electricity, Power and Gas.*

NOTES

Pittsburgh, Pa., is hereafter to have its name always spelled with the h as above, the feelings and wishes of the Pittsburghers being accounted of more weight than those of all the "simplified" spellers in the United States.

The firm of Krupp, in Essen, Germany, this year celebrates its hundreth anniversary. The firm was established in 1811, and for fifteen years only six persons were employed. Now the total number of employes is 70,000.

Machinery arrangement, artificial shop lighting and the advantages and disadvantages of concrete floors, composition floors and wood floors for manufacturing plants are to be made the special subject for a meeting Tuesday evening, October 10, of the American Society of Mechanical Engineers, at the Engineering Societies Building, 29 West Thirty-ninth street, New York City.

The Alexander Gibson, believed to be the last full-rigged American ship, is being dismantled for conversion into a coal barge. Her tonnage is only about one-twentieth of that of the biggest steamships of to-day.

More acetylene gas can be transported in the form of calcium carbide, and at less cost than in any other way. A can of carbide 13 by 23 inches weighs 100 pounds and will yield 400 cubic feet of acetylene. Transportation in this form is of course absolutely safe.

Old Sanly McPherson and young Aleck McDonald were working together over at the power plant, when Aleck says, "Sandy, what is this 'ere stuff they call vaakum?" Sandy replies: "It is naught, lad; it is nothing." Aleck says: "Sure it must be som'ot, Sandy, it must be something, for they keep it in pipes here."—*Power.*

Carbonic acid in the atmosphere arises from respiration of animals, from processes of combustion, from the decomposition of organic substances. Boussingault estimated that in Paris the quantities of carbonic acid produced every 24 hours were: population and animals, 11,895,000 cubic feet; combustion, 92,-101,000 cubic feet.

A mixture of acetylene and air becomes explosive when there is 3.35 per cent. of acetylene present; while a mixture of coal gas and air does not become explosive until the amount of gas present reaches 7.9 per cent. Air may be added to coal gas and the mixture will not become explosive until the percentage of coal gas is reduced to 19.1 per cent. of the mixture; while if air is added to acetylene the mixture becomes explosive as soon as the acetylene has fallen to 52.3 per cent.

The use of stage compression of air at high altitudes is recommended by the fact that a larger percentage of saving is possible by this system than would accrue at sea level. The compressor must be larger for a given output than at normal atmospheric pressure, and the first cost, accordingly, greater. The ratio of

compression is smaller at the high altitude, and the percentage loss from piston clearance larger, while the value of the inter-cooler is greater where the range of pressure through which the air must be carried is increased.

According to the Consolidated Gas Company of New York City, it requires 810,000 tons of coal per year to make gas for the boroughs of Manhattan and the Bronx. This means 20,250 cars of 40 tons capacity each, or a train about 130 miles long. With this coal, 90,000,000 gallons of oil also are used. Figuring this on its equivalent heating value in coal, and allowing 3.7 pounds of coal per horsepower-hour, this fuel would develop 80,000 horsepower for one year of 365 days of 24 hours each. For 300 days of 10 hours each, it would develop 234,000 horsepower.

The importation of needles at Chungking last year increased by 31,963,000 to 334,700,000. In many parts of the province these are put to a use that is not, perhaps, generally known. It is customary to ornament the center of the roof ridge of a Chinese house with an elaborate plaster decoration—usually in the form of a design embodying the character *fu*, meaning "happiness." To prevent this being damaged by the depredations of crows, large numbers of needles are stuck point outwards into the plaster while it is still soft.

M. Chaumet, the French Postmaster-General, has decided to offer a prize for the best pneumatic-tube system. The "petitbleu," or threepenny pneumatic post, which is often as speedy as a telegram, and enables a long communication to be cheaply sent, has become so popular in Paris that the service has recently been extended to all the nearer suburbs. A further extension is provided for in the 1911 Budget, and M. Chaumet is anxious to find out if some improvement cannot be secured by changing the existing plant. Three prizes are offered: $300, $200 and $150 respectively.

In probably the first accident of the kind, Philip Burrell was burned to death and "Pick" Mann was perhaps fatally injured when a threshing outfit exploded a gas pipe on a road two and a half miles north of Lawrenceville, Ind. Burrell had been operating the outfit for his father, William Burrell, and while going along the road the heavy traction engine ran over a high pressure gas line, breaking the pipe. Instantly the flames shot 50 ft. upward through the leak, enveloping the engine, separator and stacker of the threshing outfit. Burrell, who was the engineer, was caught between the engine and the separator and slowly burned to death. Mann, who was riding on the thresher, leaped to the ground, and, although flames enveloped him, he managed to get out of the zone of the fire, but not until he had been dangerously burned.

There is a great deal of discussion at the present time on the needless waste of using compressed air for atomizing purposes when superheated steam will answer, but in the small casting business one of the main difficulties is getting the metal hot enough to run the thin sections in the molds, and since, by its very nature compressed air, while atomizing the oil, furnishes at the same time oxygen for combustion, and that, too, very intimately mixed with the oil, it is quite evident that by using air we would get quicker combustion, a shorter flame and a somewhat hotter furnace.

"As drunk as a fish" is a common expression, but not many people ever saw a fish drunk. However, those who attended a temperance demonstration by E. F. Sutherland, of Columbus, Ind., were permitted to see intoxicated fish. Sutherland placed fish in a tank of water and added alcohol to the water. In a little while the fish began cutting capers that would have surprised any self-respecting members of the finny tribe. By and by the alcohol became too strong for the fish, and they started to turn on their backs. Sutherland saved their lives by transferring them to fresh water.

A peculiar mine-cage accident, Sept. 3, in the shaft of the Black Rock mine, near Butte, Mont., caused the death of six miners. A load of dull drill steels was being hauled to the surface on the cage, and the six men boarded the cage to ride up with the steel, in violation of the mine rules. According to press reports, the drill steels became dislodged during the ascent so that some of them projected from the cage and struck against the sides of the shaft. This caused their other ends to thrash about in the cage. The men

were bruised and mutilated by the steels and, according to reports, were finally swept from the cage, falling 1,400 ft. to the bottom of the shaft.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 1.

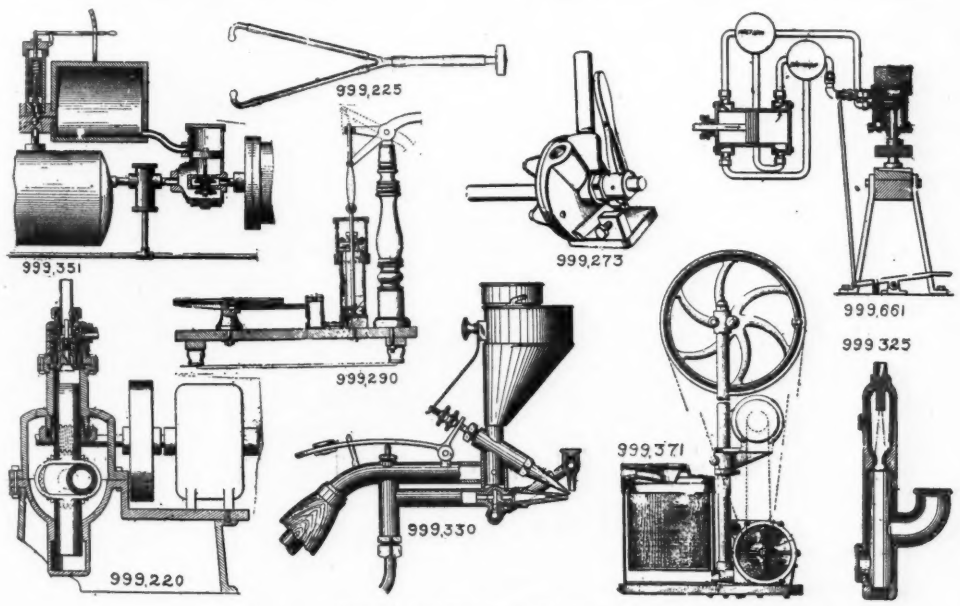
999,220. AIR OR GAS COMPRESSOR. CHRISTOPHER C. HARMON, Charlotte, N. C.
999,225. VIBROSCOPE. CHARLES F. HOPEWELL, Newton, Mass.
999,269. PNEUMATIC DUST-SEPARATOR. IRA H. SPENCER, Hartford, Conn.

AUGUST 8.

999,732. AIR-BRAKE FOR VEHICLES. CHARLES ANSPACH, Amherst, Nebr.
999,779. PNEUMATIC CLOCK. AUGUSTUS L. HAHL, Chicago, Ill.
999,870. ELECTRICAL APPARATUS. KARL C. RANDALL, Edgewood Park, Pa.

2. The combination with electric apparatus and an inclosing casing therefor, of a relatively high-pressure storage reservoir, a pump for supplying dry air thereto, and means for supplying dry air from the storage reservoir to the casing at a reduced pressure.

999,880. HOT-AIR PRODUCER AND BLOWER. AUGUST SCHAEFFER, Frankfort-on-the-Main, Germany.
999,985. OVERDRAFT-BLAST FOR FORGES. JOHN GEIST, Nashville, Tenn.
1,000,001. VACUUM APPARATUS FOR HYPEREMIC TREATMENTS. ROBERT A. C. HOLZ, Cleveland, Ohio.
1,000,021. PUMP. JOHN LEE LATTA, Hickory, N. C.
1,000,032. PNEUMATIC STACKER. WILLIAM RUSSELL MILLER, Hamilton, Ontario, Canada.



PNEUMATIC PATENTS AUGUST 1.

999,273. FLUID-PRESSURE VALVE. WILLIAM W. TEMPLES, Columbus, Ga.
999,290. VACUUM-PUMP. FRANK ARONSON, Evanston, Ill.
999,325. VACUUM CLEANING APPARATUS. GEORGE W. MACKENZIE, Ben Avon, Pa.
999,330. PAINT OR COLOR DISPERSER WITH MORE THAN ONE AIR-NOZZLE. HANS MIKOREY, Schoneberg, near Berlin, Germany.
999,351. AIR-BRAKE APPARATUS. JOHN H. WALLACE, San Francisco, Cal.
999,371. VACUUM-CLEANER. WILLIAM H. KELLER, Philadelphia, Pa.
999,506. AIR-TIGHT VALVE FOR PNEUMATIC TIRES. MORRIS LEVRANT, New York, N. Y.
999,604. PNEUMATIC DUST-SEPARATOR. IRA H. SPENCER, Hartford, Conn.
999,661. AUTOMATIC TOOL-FORGING MACHINE. LORENZA H. KUNKLE, Altoona, Pa.
1,000,075. TUNNELING-MACHINE. WILLIAM R. COLLINS, Georgetown, Colo.
1,000,130. ROCK-DRILL. JAMES A. THOMPSON and EDWIN M. MACKIE, Franklin, Pa.
1,000,169. WATER-ELEVATING APPARATUS. THOMAS W. GRAY, Woodville, Pa.

1. In a liquid-lifting apparatus controlled by a supply of compressed fluid, a liquid-holding chamber, an outlet pipe therefor, an inlet valve-seat between the compressed-fluid supply and the chamber, a valve actuated by differential pressure and seating in the direction of the flow of fluid through the seat and having its smaller area in contact with the fluid, an exhaust valve-seat for the said chamber, a valve therefor actuated by differential pressure and seating in the direction of the flow of the exhaust fluid from the chamber through the said exhaust valve-seat, a passage leading the compressed-fluid supply to the larger areas of the said valves, and means controlled by the liquid-level in the chamber for

exhausting the pressure on the said larger areas of the valves when the liquid is at a minimum low level and for closing the said fluid exhausting means when the liquid is at a maximum higher level.

1,000,182. AERATING - MACHINE. JOSIAH CHARLES FREDERICK LAWRENCE, Prahran, near Melbourne, Victoria, Australia.

1,000,193. REVERSING-VALVE MECHANISM. WILLIAM C. POST, Estherville, Iowa.

1. In an air pump for locomotives, the combination with opposed cylinders, of a reversing valve and a reciprocable valve operating stem arranged on one end of the cylinders, pistons respectively arranged within each of the cylinders and connected by a piston rod, one end of the piston rod projecting beyond the end of the cylinder opposite the reversing valve and its stem, a valve rod movably supported by the cylinders and arranged in parallel with the said piston rod, an arm connecting the valve rod and the valve stem, and means connecting the piston rod and the valve rod for moving the latter and thereby actuating the valve stem upon movement of the said pistons in either direction.

1,000,561. AUTOMATIC PIANO. FLOYD F. STAUFFER, Dallas, Tex.

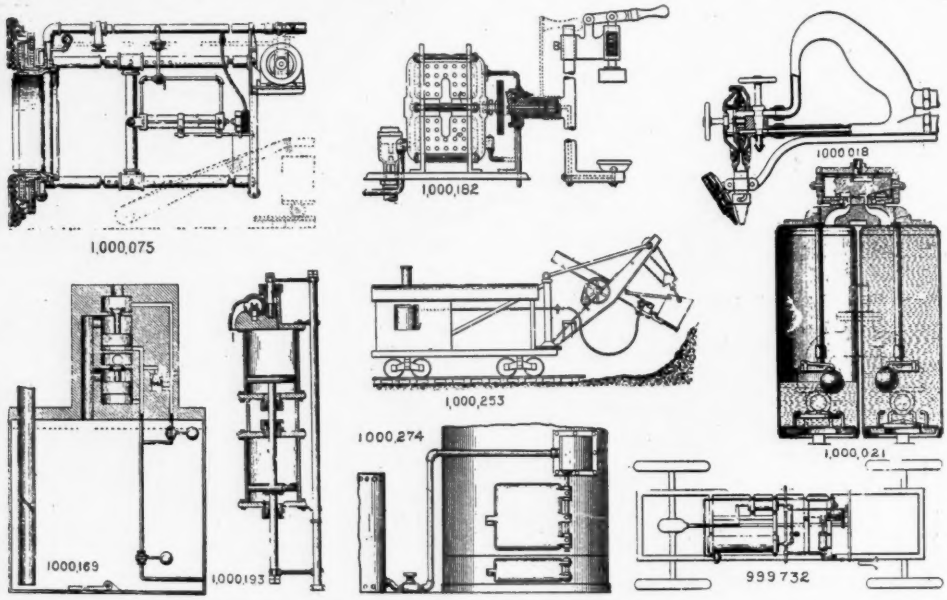
1,000,566. ROTARY PUMP FOR VACUUM SYSTEMS. AXEL WESTER, Minneapolis, Minn.

1,000,568. PNEUMATIC HAMMER. MELVIN ALBERT YEAKLEY, Kamms, Ohio.

1,000,615. AIR-PUMP. CHARLES W. MCGARY, Everett, Mass.

1,000,669. APPARATUS FOR OBTAINING GAS FROM WELLS. AUGUSTUS STEIGER COOPER, Los Olivos, Cal.

An apparatus for the recovery of gas from wells consisting of a well casing provided above the liquid column with a gas outlet, of a continuously open flow pipe extending down from the surface of the well to the vicinity of its bottom and closed at its lower end to the liquid of the lower portion of the liquid column in said well, a second continuously open pipe, the upper end of which is open to the liquid of the upper portion of said liquid column and thence extending down in the well, its lower end communicating with the lower end of the flow pipe to deliver thereto liquid only from the upper portion of the liquid column, a pipe extending from



PNEUMATIC PATENTS AUGUST 8.

1,000,253. DIPPER-TRIP FOR STEAM-SHOVELS. ALBERT H. GEDDES, Empire, Canal Zone.

1,000,274. FURNACE-DOOR OPENER. SHEPARD LYON, Sault Ste. Marie, Mich.

1,000,286. LIQUID-PISTON VACUUM-PUMP. MARCEL ANDRE MOULIN, Paris, France.

1,000,298. PREPARATION FOR SLOWLY LIBERATING OXYGEN. LEOPOLD SARASON, Hirschgarten, near Berlin, Germany.

AUGUST 15.

1,000,377. ACCENTING DEVICE FOR PNEUMATIC-PIANO-PLAYER ACTIONS. JAMES W. CROOKS, Mount Vernon, N. Y.

1,000,382. VACUUM CLEANING-MACHINE. ORA DRAKE, Cleveland, Ohio.

1,000,467. PRESSURE-REDUCING MECHANISM FOR MOTIVE-FLUID DRILLS. DANIEL S. WAUGH, Denver, Colo.

1,000,539. GASEOUS-FLUID COMPRESSOR. ERNEST NAUER, Chicago, Ill.

a source of air pressure down into the well and provided at its lower end with an upturned portion projecting into the lower end of the flow pipe and adapted to deliver a stream of air under pressure therein.

1,000,689. PULP-AGITATING APPARATUS. WILLIAM CAMPBELL PATERSON, Denver, Colo.

1,000,690. WINDMILL-ACTUATED AIR-COMPRESSOR. STEPHANE PICHAULT, Valenciennes, France.

1,000,713. COMPRESSED-AIR WATER-ELEVATOR. FRANK PETER CALLOW, Salt Lake City, Utah.

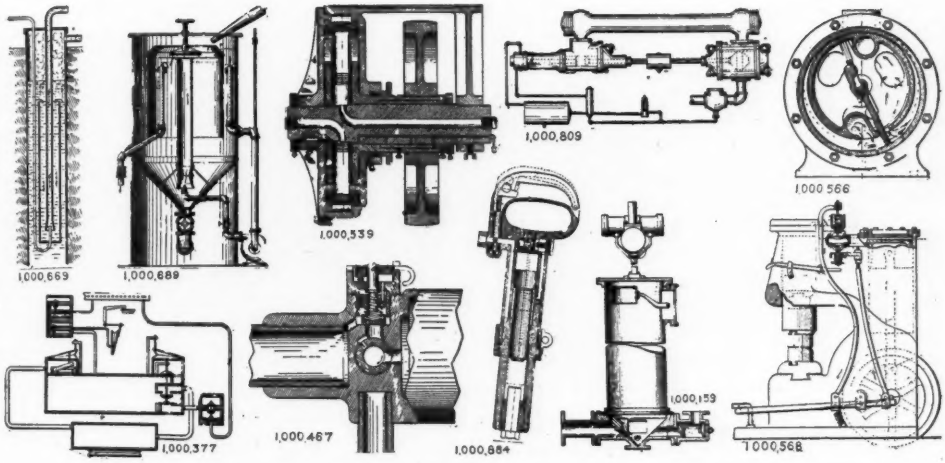
1,000,721. DIVING-HELMET. ANTON CYPRA, Worcester, Mass.

1,000,729. FLUID-PRESSURE REGULATOR. AUGUST GLOECKLER, Chicago, Ill.

1,000,759. AIR-PUMP. PAUL SCHOU, Copenhagen, Denmark.

1,000,809. AIR-COMPRESSOR. EBENEZER HILL, Norwalk, Conn.

1,000,858. VACUUM-CLIP. CHARLES B. ULRICH, Hancock, Mich.



PNEUMATIC PATENTS AUGUST 15.

1,000,884. PNEUMATIC TOOL. ALBERT BALL, Claremont, N. H.

1,000,905. PRESSURE-FED TOOL. GEORGE H. GILMAN, Claremont, N. H.

1,000,972. ELECTRO-PNEUMATIC PHOTO-EXPOSURE APPARATUS. KARL W. THALHAMMER, Los Angeles, Cal.

2. The combination in electro-pneumatic photo exposure apparatus of pneumatic mechanism for operating a camera shutter, an air-tank provided with an outlet, means to compress air in the air-tank, a tube leading from such outlet to said pneumatic mechanism, a valve to normally close the outlet, and electro-magnetic means to open the valve.

AUGUST 22.

1,000,979. PNEUMATIC - DESPATCH - TUBE APPARATUS. LOUIS G. BARTLETT, East Somerville, Mass.

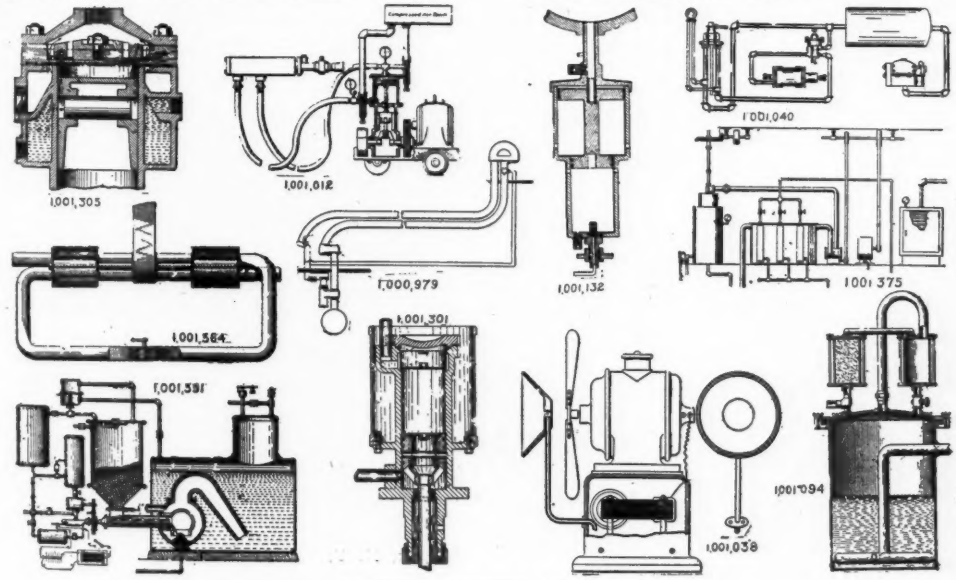
1,001,012. PNEUMATICALLY - OPERATED ROCK-DRILLING ENGINE. GEORGE A. FOWLER, Denver, Colo.

1,001,038. APPARATUS FOR PURIFYING AIR. FRIEDRICH GEORG JANICH, Rheydt, near Dusseldorf, Germany.

1. An apparatus for the distribution of ozone in the air comprising in combination a fan, an ozonizer with discharge conduit opening in front of the blades of this fan and a funnel-shaped screen with closed bottom arranged between the said blades and the discharge conduit.

1,001,040. AIR-BRAKE EMERGENCY-VALVE. LEE O. JOHNSONBAUGH, Lebanon, Ind.

1,001,084. SAFETY SIGNAL DEVICE FOR FLUID-PRESURE-BRAKE SYSTEMS. WILLIAM H. SAUVAGE, New York, N. Y.



PNEUMATIC PATENTS AUGUST 22.

1,001,094. AIR - FILTER. HARRY TORCHIANI, Chicago, Ill.

1,001,132. APPARATUS FOR COMPRESSING AIR. HERBERT H. FREY, Detroit, Mich.

1,001,297-8. PNEUMATIC HAMMER. REINHOLD A. NORLING, Aurora, Ill.

1,001,301. AIR OR GAS COMPRESSOR. BERNARD RATHMELL, Liverpool, England.

1,001,305. AIR-COMPRESSOR. EDWARD A. RIX, Oakland, Cal.

1,001,306. LUBRICATING SYSTEM. EDWARD A. RIX, Piedmont, Cal.

1,001,375. PROCESS OF PREPARING FOOD PRODUCTS. THOMAS EDWARDS, Washington, D. C.

1. A process for preparing oysters, clams or smilar shell fish which consists in grinding them and placing the same in a heated receptacle, then agitating the mass to break it up into small particles and at the same time forcing heated air under pressure there through to expel the moisture therefrom and reduce the mass to a mushy consistency, then subjecting to an evaporating operation and finally pulverizing the mass.

1. The combination with a generator, of a combustion chamber therein communicating with the generator, a fuel receptacle protruding into the combustion chamber, means for regulating the supply of fuel to the combustion chamber, means for supplying the combustion chamber with fluid fuel and air under pressure, and means for igniting the fluid fuel under pressure, substantially as described.

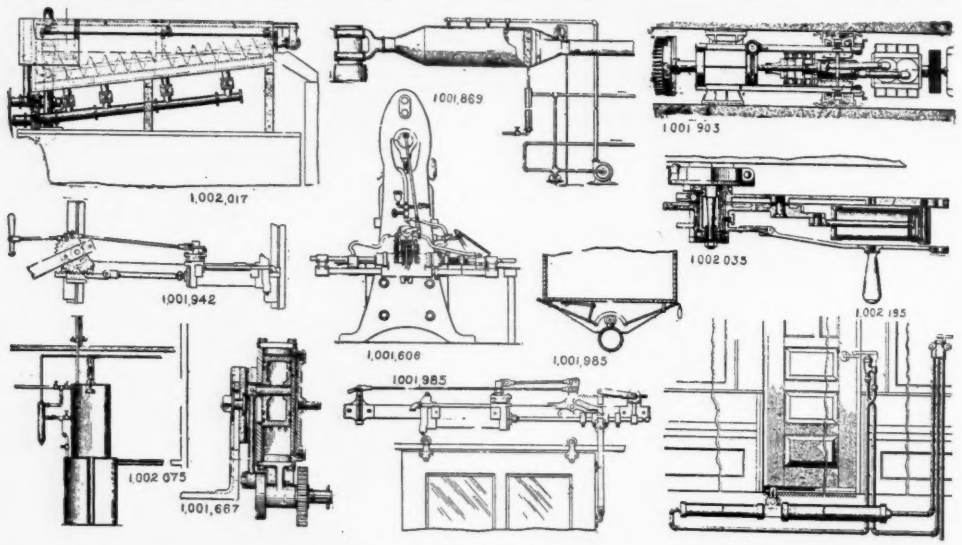
AUGUST 29.

1,001,606. AUTOMATIC PNEUMATIC FEED FOR PUNCH-PRESSES. CONRAD BAUMGARTNER, Schenectady, N. Y.

1,001,667. AIR-PUMP. JOHN J. MCINTYRE, Hartford, Conn.

1,001,869. HUMIDIFYING APPARATUS AND MEANS FOR CONTROLLING SAME. JOEL IRVINE LYLE, Plainfield, N. J.

1. Means for humidifying and cooling compressed air including means for varying the temperature of the air as the pressure thereof varies, and compensating means for proportion-



PNEUMATIC PATENTS AUUGST 29.

1,001,429. PNEUMATIC CONTROL SYSTEM. LAWRENCE S. NASH, Detroit, Mich.

1. In an automobile, change speed and reverse drive transmission mechanism, brakes, pneumatically operated means connected to the change speed and reverse mechanisms and to the brakes for throwing said mechanisms into action and for applying the brakes, and manually operable means for admitting air selectively to said pneumatically operated means adapted to automatically set the brake applying mechanism into action by admitting air thereto when shifting the air supply from the change speed to the reverse drive mechanisms.

1,001,564. ATTACHMENT FOR COTTON-GINS. JAMES L. STANDARD, Hamburg, Ark.

1. In a device of the kind described the combination with a plurality of seed boxes of a plurality of valves one of each arranged immediately below a respective seed box, and a pair of blow pipes adjacent each other arranged below each of said valves and in communication therewith, said valves adapted to direct the seed into one or the other of said blow pipes and means to direct a current of air into one or the other of said blow pipes, substantially as shown and described.

1,001,591-2. APPARATUS FOR GENERATING MOTIVE FLUID. GEORGE B. HAYES, Denver, Colo.

ing between the temperature and pressure variations to maintain a constant weight ratio between the moisture and air.

1,001,903. ROCK-CUTTING APPARATUS. ROBERT TEMPLE, Denver, Colo.

1,001,923. PNEUMATIC FOR AUTOMATIC PIANOS. WILLIAM G. BETZ, Steger, Ill.

1,001,942-3-4. PNEUMATIC DOOR-OPERATING MECHANISM. PARIS R. FORMAN, Chicago, Ill.

1,001,985. AIR-BRAKE-RELEASE DEVICE. ALEX WOODS ROLLINGS, Montgomery, Ala.

1,001,988. CUSHION MECHANISM FOR PNEUMATIC DOOR-CONTROL DEVICES. HAROLD ROWNTREE, Chicago, Ill.

1,002,017. VACUUM STOCK THICKENING AND WASHING MACHINE. THOMAS EDWIN WARREN, Ticonderoga, N. Y.

1,002,035. AUTOMOBILE AIR-PUMP. ANTOINE M. CLEMENT, New York, N. Y.

1,002,075. VACUUM-PUMP AND CLEANING APPARATUS. LEAL L. MONTGOMERY, Superior, Wis.

1,002,195. PNEUMATIC DOOR-OPERATING MECHANISM. THOMAS R. BROWN, New York, N. Y.

1,002,088. FURNACE-DOOR OPENER AND CLOSER. THOMAS E. SMYTHE, Bellefontaine, Ohio.

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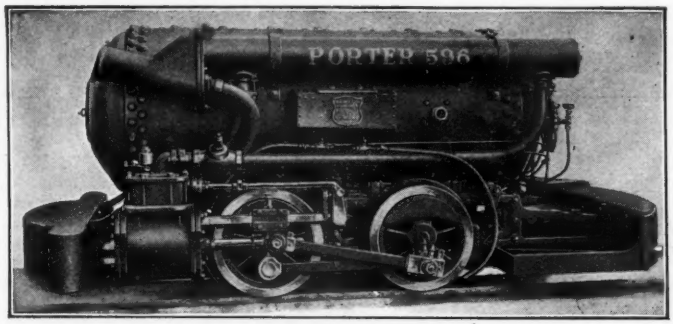

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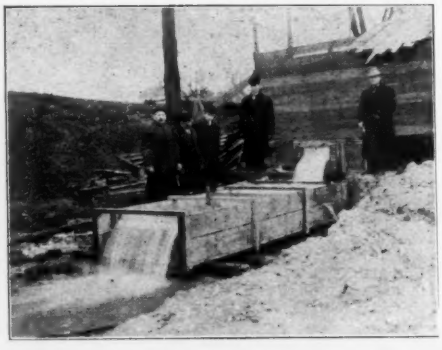

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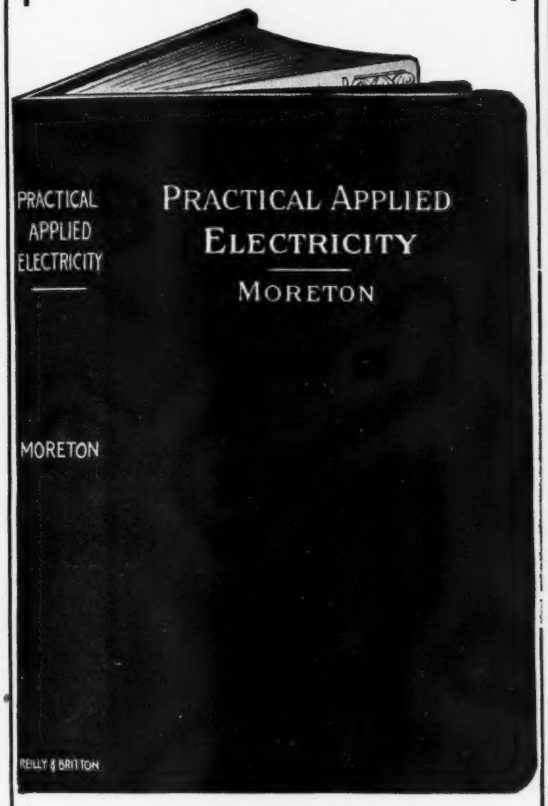

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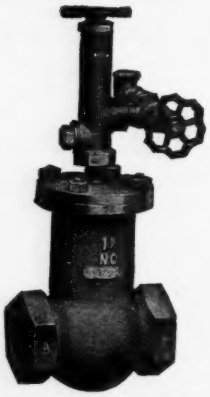

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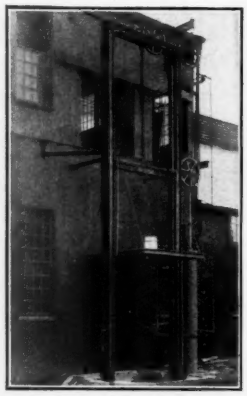

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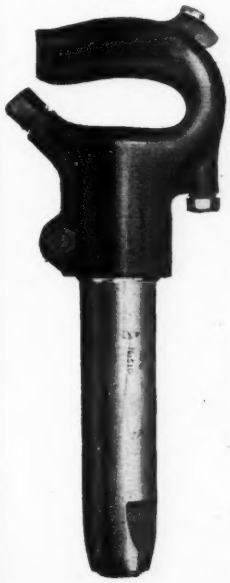

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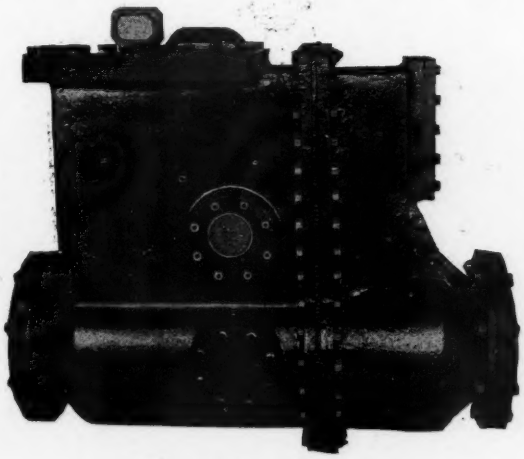

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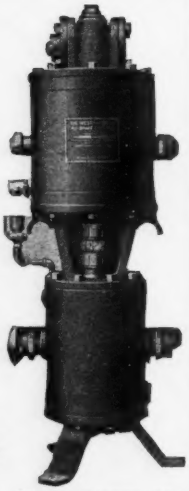

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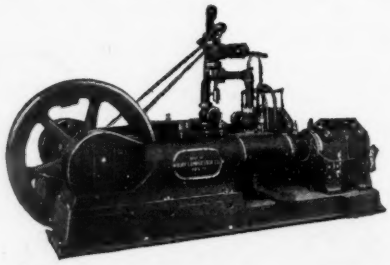

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